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Stress Testing the Private Household Sector Using Microdata

Kamil Galuščák, Petr Hlaváč, and Petr Jakubík*

Abstract

We develop a methodology for identifying financially distressed households and use it for testing the responses to shocks to the unemployment rate, the interest rate and prices of essential expenditure in the Czech Republic. We extend the approach of Johansson and Persson (2006) for Sweden and Albacete and Fessler (2010) for Austria to allow for full labour market transitions between employment and unemployment, and, due to data availability, to account for heads and spouses within households. This improvement may lead to a higher response of household distress incidence due to the unemployment rate shock than in both Sweden and Austria, while the effects due to the interest rate shock are of similar size as in Austria. We illustrate the use of our approach for stress testing households' ability to pay their debts using macroeconomic scenarios from the CNB's official forecast and from the CNB's Financial Stability Report. The results highlight the importance of using micro-level datasets in the analysis of household distress incidence, as the impact of shocks is more pronounced among lower-income households.

Abstrakt

Představujeme metodologii pro identifikaci předlužených domácností, kterou používáme pro testování reakcí na šokové změny míry nezaměstnanosti, úrokových sazeb a cen nezbytných výdajů v České republice. Rozšiřujeme přístup použitý v Johansson a Persson (2006) pro Švédsko a Albacete a Fessler (2010) pro Rakousko tím, že uvažujeme obousměrné toky na trhu práce mezi zaměstnaností a nezaměstnaností, a také tím, že díky dostupnosti dat zahrnujeme do testování nejen hlavy domácností, ale i jejich partnery. Toto vylepšení může vysvětlit pozorovaný vyšší výskyt předluženosti v případě šokových změn nezaměstnanosti než ve Švédsku a Rakousku, zatímco dopady šokových změn úrokové míry jsou podobné jako v Rakousku. S využitím makroekonomických scénářů z prognózy ČNB a ze Zprávy o finanční stabilitě ilustrujeme využití našeho přístupu pro zátěžové testování schopnosti domácností splácet dluhy. Výsledky potvrzují důležitost využívání mikrodat v analýzách finančního zatížení domácností, protože dopady šoků jsou vyšší mezi nízkopříjmovými domácnostmi, což by při použití agregátních dat nebylo zřejmé.

JEL Codes: D12, D31, E17.

Keywords: Ability to pay, financial surplus, household indebtedness, microdata, stress testing.

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Nontechnical Summary

We develop a methodology for identifying financially distressed households, who may default on their debt repayments, and illustrate its use for stress testing households' ability to pay their debts by examining the effects of shocks to household budgets in the Czech Republic. Distress is associated with a fall in the financial surplus – defined as net household income net of debt repayments and essential costs of living – into negative values. Our approach builds on Johansson and Persson (2006) for Sweden and Albacete and Fessler (2010) for Austria. In particular, we investigate shocks to the unemployment rate and the interest rate, while we also consider price shocks affecting households' essential expenditure. In contrast to the previous literature, we account for labour market transitions between unemployment and employment, and, thanks to data availability, allow the unemployment rate shock to affect household heads as well as their spouses. This improvement may lead to a higher response in the percentage of household distress to the unemployment rate shock than in Sweden (Johansson and Persson, 2006) and Austria (Albacete and Fessler, 2010). This underlines that it is important to account for spouses within households, who experience higher labour market transitions than household heads. Furthermore, the effect of interest rate shocks on the incidence of financial distress is similar as in Austria, while it is significantly lower in Sweden due to a much lower ratio of interest payments to disposable income.

Our results indicate that the impact on households' ability to pay is largest in the case of the unemployment rate shock. This impact is of roughly similar magnitude to the long-term effect of the interest rate shock, where we assume that all loans are renegotiated at higher interest rates. On the other hand, the short-term effects of the interest rate shock, i.e. the effects within one year, when only part of the loans are renegotiated, are about half the size of the long-term effects. Finally, price shocks to essential expenditure cause very small changes in the incidence of financial distress among Czech households. This result may be partly due to using non-zero price and income elasticities of demand in the case of the broader definition of essential expenditure which attenuates the effects of the price shock. We investigate the impact of particular shocks to the average financial surplus, and we also consider the effects of the unemployment rate shock combined with the shock to the interest rate.

In the final part, we demonstrate the use of our approach to stress testing the private household sector under various macroeconomic scenarios. In particular, we apply the CNB's macroeconomic forecast as a baseline for 2013 and an alternative scenario from the CNB's Financial Stability Report 2012/2013 which assumes adverse economic developments in 2013. The results of this exercise highlight the importance of analysing the effects of macroeconomic shocks with the use of individual-level data, as the impact on household financial distress is significantly higher among lower-income households. Our methodology stands as an alternative to the calculation of households' average probability of default. This represents a significant improvement on the stress test methods previously used at the CNB.

1. Introduction

The financial crisis of 2008–2009 underscored the importance of monitoring and assessing risks in the household sector caused by the excessive accumulation of debts. In the pre-crisis period, household indebtedness increased to historical highs in a number of OECD countries. The growth was driven by favourable financial conditions, easier access to credit for lower-income borrowers due to supply-side innovations in credit markets, and buoyant housing markets (Girouard et al., 2006). These developments leveraged households' balance sheets and increased their sensitivity to interest rates and house prices. Debt accumulation may help smooth real activity, but high levels of debt lead to vulnerabilities which amplify the transmission of macroeconomic and asset price shocks (Sutherland and Hoeller, 2012). While in the pre-crisis period most of the debt had been held by higher-income households, which are better able to service their debts, the importance of the indebtedness of lower-income households and spillovers to the rest of the economy increased during the crisis of 2008–2009.

This experience highlights the importance of conducting microeconomic analyses of the household sector to capture the different impacts of a deterioration in the macroeconomic environment on different income groups of the population. Moreover, excessive credit growth and overly relaxed credit standards before the crisis gave rise to sharp growth in the credit risk of the banking sector during the crisis. As a result, financial regulators are developing tools for monitoring systemic risk in the household sector and for stress testing household balance sheets.[1]

In this paper we refine the methodology for identifying financially distressed households, who may fall into difficulties in repaying their debts. We associate distress with a fall in the financial surplus – defined as net household income minus debt repayments and essential living costs – into negative values. We investigate shocks to the unemployment rate, the interest rate and prices affecting households' essential expenditure in the Czech Republic. We extend the approach of Johansson and Persson (2006) for Sweden and Albacete and Fessler (2012) for Austria by allowing for full labour market transitions between employment and unemployment, and, due to data availability, we are able to assess the effects on household heads as well as their spouses. Our results suggest that this improvement may explain the higher response in the percentage of distressed households to the unemployment rate shock than in Sweden and Austria, while the effect of the interest rate shock is similar as in Austria. We find that the unemployment rate shock has the greatest impact on the ability of Czech households to pay their debts. This impact is of similar size to the long-term effect of the interest rate shock, where we assume that all loans are renegotiated at higher interest rates. On the other hand, the short-term effects – where only part of loans are refixed – are about half the size of the long-term effects, and the effects of the price shock are very small. We illustrate the use of our approach to stress testing the incidence of financial distress under macroeconomic scenarios from the CNB's official forecast and from the CNB's Financial Stability Report. In sum, the results underscore the importance of using microeconomic data in the analysis of the effects of macroeconomic shocks to households' ability to pay their debts. We show that although the debt is concentrated among higher-income households, lower-income households are more vulnerable to

[1] Frait and Komárková (2012) describe how systemic risk evolves over the financial cycle and propose a framework for a bank-based economy with a simple financial sector similar to the Czech Republic with the aim to prevent systemic risk in the accumulation phase of the cycle and to mitigate its effects.

adverse economic developments. Our results may be used to estimate households' average probability of default, which could serve as an input to the CNB's bank stress tests.[2]

The paper is organised as follows. The next section provides a review of the previous literature relevant to our approach. Section 3 describes our methodology. In Section 4 we describe the available datasets, Section 5 summarises the results, and the final section concludes.

2. Previous Literature

There are many studies in the literature dealing with the identification of household financial distress and its macroeconomic implications. Some studies focus on the key determinants of the risk of insolvency or distress and the links between these risks and developments in the macroeconomic environment, while others examine the impacts of various macroeconomic scenarios on household consumption. In the past, insufficient attention was devoted to these issues owing to limited availability of statistics covering households' structured balance sheets and household consumption. The recent financial and economic crisis has sparked interest in this issue among regulators as well as financial institutions that lend to households.

Most of the papers we refer to in this section define the financial surplus (or margin) of a particular household as

$$FS = Y - C, \tag{1}$$

where Y is net household income and C are necessary costs of living including household expenditure. The financial surplus FS expresses the net household income left after paying all necessary expenditure related to consumption and living. The probability of distress is then defined as a situation where FS declines below zero or some specific threshold. Equation (1) and the associated probability of distress are then used for stress testing. In particular, increasing unemployment or costs of living contained in macroeconomic scenarios directly affect net household income Y or the costs of living C.

Herrala and Kauko (2007) describe the model used by the Finnish central bank to forecast distress in the household sector. Distress is defined as a situation where the financial surplus (FS), defined as the net income of households (Y) minus essential living costs and debt service payments (C), is too low. The model inputs are the macroeconomic forecast and a micro data set of households. The authors simulate the impacts of shocks to unemployment, affecting household income Y, and to interest rates and housing prices, both affecting the costs of living C, on the level of distress. The results show that shocks to interest rates have a larger impact than changes in unemployment and housing prices, because most household loans bear variable interest rates.[3]

Johansson and Persson (2006) simulate the risks of default by Swedish households in the event of a rise in unemployment, a rise in interest rates and a fall in asset prices. Distress is associated with a negative financial surplus, defined as the household's income net of debt service costs and essential living costs. If

[2] Credit risk resulting from impairment in debt repayments may represent the main source of risk for the financial stability of the Czech banking sector. Hence, we focus in our approach on the impact of various shocks on indebted households.

[3] The model is used to simulate the impacts of 1 standard deviation shocks added to a basic scenario. The standard deviations of the variables are calculated for the period 1986–2005. The authors admit that the impact of the interest rate shock is larger because the rates were higher and more volatile in the run-up to Finland's accession to the EMU in 1999.

the surplus is less than zero, the household defaults on its debts. The ultimate aim of their paper is to identify potential losses for the banking sector. The calculation of banks' losses assumes that a negative surplus is covered by households up to the value of their assets. In particular, the authors calculate *exposure at default (EAD),* which measures the proportion of total household debt held by households with a negative financial surplus, and *loss given default (LGD),* defined as the share of debt held by households with a negative surplus that cannot be covered by households' assets.[4]

Johansson and Persson show how households' ability to service their debts and the risk of loan losses are affected by changes in interest rates, unemployment and asset prices.[5] The effects of interest rate changes depend on the proportion of fixed-rate loans. Hence, the authors distinguish short-term effects, where an interest rate change affects variable-rate loans, and long-term effects, where all loans are renegotiated. The results indicate that a 1 percentage point rise in interest rates would have practically no impact on the credit risk of the banking sector, and that even a 3 percentage point increase in interest rates would not significantly increase Swedish banks' credit risk in household lending. The effects of unemployment rising by 1 to 3 percentage points are simulated using a Monte Carlo approach assuming that employed persons have an equal probability of becoming unemployed and that loss of employment means a fall in income expressed as the difference between the wage and the unemployment benefit. It is also apparent from the results that rising unemployment entails an even lower risk of default than rising interest rates.[6] Finally, Johansson and Person investigate how the LGD is affected by the combined effect of an interest rate increase and a fall in asset prices. The results show that a 20 per cent fall in house prices combined with a 3 per cent interest rate hike would shift the LGD from 0.9 to 1.7 per cent in the long run. The authors conclude that this does not bring the Swedish banking sector under significant strain.

Albacete and Fessler (2010) describe the household stress test methodology used in the Austrian central bank. Combining different household microdata sources, the authors assess the impacts of macroeconomic scenarios (changes in interest rates, the unemployment rate, asset prices and the exchange rate) and test households' ability to pay their debts. In particular, a household defaults on its debts if the financial surplus FS defined in (1) is negative, while the probability of default is zero if the surplus is zero or positive. Similarly to Johansson and Persson (2006), they construct the EAD and LGD measures. The scenario of rising unemployment is quantified for employed household heads by modelling the probability of becoming unemployed in relation to demographic and socio-economic characteristics. Using the coefficient estimates, a rise in the unemployment rate is simulated by increasing the constant of the model until the unemployment rate matches a certain value. If the assigned probability of being unemployed is greater than a random number drawn from a uniform distribution, the person is assumed to be unemployed and receiving unemployment benefit. These steps are repeated in a Monte Carlo simulation and the vulnerability indicators are calculated in each step, and the means are then computed over all the simulated draws. The results of the simulations reveal that rising interest rates have a larger negative impact on households' ability to repay than rising unemployment, due to the fact that approximately two-thirds of Austrian debtors have variable-rate loans. The banking sector's potential

[4] The LGDs are not the same as those calculated by banks. The purpose is not to replicate the LGDs used by banks, but to use a risk metric that the authors are able to construct given the available data.

[5] This approach abstracts from business cycle effects. In particular, interest rates and household income normally increase with more robust economic activity.

[6] The household debt is concentrated among the highest income category. These households are often formed by two employed adult persons. If one adult loses his job, the other person's income is sufficient to cover living costs and interest outlays.

losses resulting from the shocks considered do not compromise financial stability, but a risk is identified in the case of foreign currency loans due to potential exchange rate changes.

Bičáková et al. (2010) describe the evolution of the indebtedness of Czech households over the previous decade using the average debt burden (DB) of households which borrow, defined as the ratio of the annual amount of loan repayments to household disposable income.[7] The authors propose an alternative measure – the adjusted debt burden (ADB), defined as the ratio of loan repayments to household disposable income net of the household-specific living minimum.[8] The ADB thus reflects differences in households' living costs across households of different size and composition. They augment the analysis with the Statistics on Income and Living Conditions (SILC) in 2005–2008, which contain information on households' repayment behaviour. Default is thus defined as an inability to service a debt on time. Exploring the relationship between the level of the debt burden and the occurrence of delayed loan repayments, they identify the cut-off point above which default is likely. The authors find that the ADB is correlated twice as strongly with delayed repayments than the standard debt measure DB. They propose a cut-off point of 30 per cent in the ADB to be used as an indicator of households' overindebtedness. The results reveal substantial regional variation in borrowing among Czech households. The proportion of households with a loan ranges from 25 per cent to almost twice as much across regions, while the share of overindebted households with ADBs above 30 per cent varies from 4.3 to 16.5 per cent.

Jakubík (2010) investigates the extent of households' financial distress caused by adverse macroeconomic shocks and considers the effect of household insolvency on aggregate consumption. Due to a lack of appropriate micro data, he simulates the impact of negative income shocks, due to either a wage drop or higher unemployment, on typical family budgets. Household distress is defined as a situation where the financial surplus in (1) is close to zero and the household is only able to cover the essential costs of living. The results indicate that 30 per cent of households with a mortgage would be distressed when facing a 10 per cent fall in income. The percentage of distressed households increases to 50 per cent if they also had a consumer loan of a typical amount. The author admits that these results overestimate the effect of an income drop on household insolvency due to, for example, the assumption of constant living costs. Jakubík also shows that increased household insolvency negatively affects economic activity through lower household consumption. In particular, a 5 percentage point increase in the insolvency rate causes an additional decline in GDP by 1 percentage point.

Most of the studies we describe in this section work with microeconomic data and analyse how households' distress – usually defined in relation to their financial surplus – changes in response to shocks to unemployment and interest rates. In some cases, other types of shocks – such as changes in the exchange rate – are considered, but the most typical scenario is that of a rising number of distressed households due to increasing unemployment. Our chosen approach to identifying distressed households and to stress testing reflects the microdata available in the Czech Republic and extends the approach used in Albacete and Fessler (2010) and Johansson and Persson (2006) in several dimensions. First, while both studies consider transitions of employed individuals into unemployment in a scenario of increasing

[7] Less than 40 per cent of households had at least one loan in 2000–2008, while the average amount of debt among households that borrow increased from 7 to 11 per cent of disposable income, particularly for young households with higher income levels, due to expansion of the housing loan market. Czech household indebtedness as measured by the loans-to-GDP ratio was lower than in the euro area and similar to that in other Central European economies.

[8] The living minimum is declared by the Ministry of Labour and Social Affairs and covers minimum living costs in relation to the demographic composition of the household.

unemployment, in our methodology we also consider transitions from unemployment to employment.[9] Second, unlike in Albacete and Fessler (2010), the household micro data we use allow us to model transitions between labour market states for household heads and spouses. In the following section we provide a more detailed description of our extended approach to stress testing the private household sector using micro data.

3. Methodology

The insolvency risk in the Czech household sector transforms into credit risk of the financial sector via household debt. Stress tests of the household sector are therefore aimed at quantifying this risk using estimates of the percentage of distressed households, similar to the aggregate probability of default (PD) ratio. Because micro data on household wealth and loan principal are not available to us, we are not able to calculate the LGD and EAD indicators.

3.1. Identification of Distressed Households

Albacete and Fessler (2010) and Johansson and Persson (2006) identify distressed households as those with a negative financial surplus as defined in (1). Bičáková et al. (2010) introduces the DB and ADB measures based on the ratios of loan repayments to household disposable income. If we define distressed households as those with a DB and ADB of less than unity, this is equivalent to a negative financial surplus of the type of (1).[10] Hence, we rely on the measure of financial surplus (FS) defined in (1). In particular, we use the following form of the financial surplus:

$$FS = NI - INST - EE \tag{2}$$

where NI is household net monthly income, INST is monthly instalments and EE is essential monthly expenditure, defined as the sum of expenditure in groups which are typical for essential goods (food, energy, health and rent).[11] We identify the household as distressed if the FS indicator defined in (2) is negative.

We consider three types of shocks in our simulations. Each of them has an impact on one of the variables entering the financial surplus calculation in equation (2). Shocks to unemployment influence net household income (NI), as work income is replaced by unemployment benefit or other social income. Shocks to interest rates affect instalments (INST). Finally, we consider shocks to prices affecting essential expenditure (EE). We consider shocks of the size of multiples of the standard deviation of the variables so that the effects of the shocks are comparable. Next, we report the effects of joint shocks to the unemployment rate and the interest rate, and for specific macroeconomic scenarios assuming baseline and alternative economic developments in 2013 (CNB, 2013a, 2013b).

[9] Shocks to unemployment influence not only the probability of becoming unemployed, but also unemployed persons' chances of returning to work. Previous literature highlights the importance of unemployment duration on the level of unemployment (see e.g. Elsby et al., 2013).

[10] Moreover, the amounts of the living minimum related to household expenditures used by Bičáková et al. (2010) in the ADB measure were abolished in 2007, which would complicate its use in the more recent period.

[11] As an alternative we consider the amounts of the statutory living minimum (subsistence minimum amounts) as essential expenditure in (2).

Our approach is data driven, as it is limited by the data availability. The dataset does not contain household balance sheet data, limiting our methodology to some extent. In particular, we are not able to simulate a shock in the form of a fall in housing prices, as information on the value of the property owned by households is not available. However, the majority of Czech households use their property as their own place of residence. This limits the potential impacts of a fall in prices of real assets on their budgets, as households do not usually view their own place of residence as an asset prone to be sold if they expect its price to decline in the future.[12] Moreover, our approach also excludes the impacts of exchange rate shocks. This does not limit our analysis, as exchange rate changes negatively affect household budgets primarily via foreign currency debt, while Czech households have virtually no foreign currency loans (CNB, 2013b). Consequently, Czech households, unlike their counterparts in some other European economies, are not exposed to the risk of domestic currency depreciation and subsequent growth in the domestic currency value of their debt.[13]

3.2. Shocks to Unemployment

The simulation of shocks to unemployment is based on the breakdown of household heads and spouses by economic activity: working (state E), unemployed (state U) and economically inactive (state O). Persons outside the labour market, such as students, women on maternity leave and pensioners, are assumed to remain economically inactive over the time period considered. This assumption is broadly consistent with the evidence, particularly in the short run (see, for example, Gottvald, 2005). The novelty of our approach lies in allowing for transitions both from employment to unemployment and from unemployment to employment, and in accounting for household heads and their spouses as well.

The key concept in the unemployment scenario is the probability that a person is unemployed. This probability is expressed as

$$Prob(u_i = 1|x_i) = \phi(\alpha + \beta x_i) \qquad (3)$$

where ui is a dummy indicating an unemployed person, xi is a vector of his or her socio-economic characteristics, and Φ(.) is the cumulative density function of the standard normal distribution. Coefficient estimates from an operationalised form of (3) may be used to predict the probability of unemployment for each person.

Albacete and Fessler (2010) simulate the rise in the unemployment rate by increasing the constant α in (3) until the rate of unemployment based on the entire set of households reaches the required level. However, given the available data, our estimation of the probability of unemployment is based on three pooled cross-section datasets (for 2010–2012). In this way the individual's unobserved heterogeneity is ignored, which leads to biased coefficient estimates. Not accounting for unobserved heterogeneity may increase the predicted probability of transitions between labour market states based on (3), particularly from

[12] The impact of changes in property prices on the financial condition of Czech households is studied in detail in Brůha, Hlaváček and Komárek (2013).

[13] Exchange rate shocks affect consumer inflation through their impact on prices of imported goods. We leave the assessment of this channel of the exchange rate shock to household budgets for future research.

unemployment to employment.[14] Hence, while we simulate the higher unemployment rate by increasing the constant α in (3), we do so differently for unemployed and employed individuals to match the observed aggregate labour market flows. In particular, we increase the constant in (3) for unemployed individuals until their average transitions to unemployment match the observed aggregate gross flows. Based on the available evidence on gross labour market flows shown in Figure 1, we set the unemployment to unemployment transition probability at 50 per cent. Figure 1 also suggests that unemployment to unemployment gross flows are largely insensitive to the business cycle.[15]

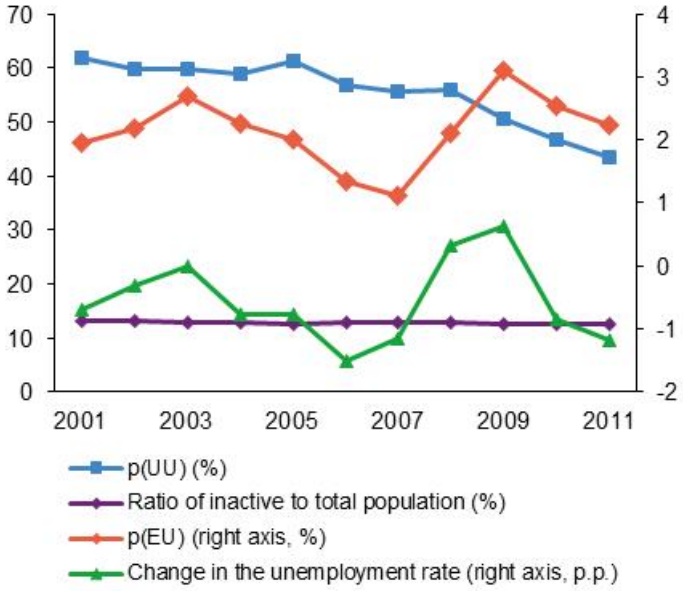
For employed individuals, their constant in (3) is increased to match the targeted unemployment rate on the overall sample. Although model (3) only assigns to each person the probability of being unemployed (and hence also the probability of being employed), the average of this measure, for example for all persons employed at the beginning of the simulation, can be interpreted as the probability of an employed person becoming unemployed. Calibrating the probit model as described above to match the observed Czech labour market flows (transition probabilities) preserves the observed heterogeneity across different individuals and also matches the observed gross labour market flows.[16]

[14] Unemployed persons lose their job skills, which is not reflected in their observed characteristics xi included in (3). The predicted probability of their transitions into employment is thus overestimated. On the other hand, employed individuals may be supposed to strengthen their job skills, which are unobserved to the econometrician, leading to overestimation of their transitions into unemployment.

[15] On the other hand, employment to unemployment flows are more closely related to the business cycle expressed as changes in the unemployment rate (see Figure 1). This is supported by simple regressions, which are available from the authors upon request. Furthermore, the evidence in Figure 1 also suggests that the share of the inactive population in the total population was unchanged throughout the period. This justifies our assumption of a constant share of the inactive population.

[16] Not calibrating the model would mean that the transition probabilities were entirely determined by the statistical significance of the relation between the covariates and the dependent variable. The tighter the relation, the lower the flows from employment to unemployment, and vice versa.

Figure 1: Gross Labour Market Flows



Note: Probability of transitions from unemployment to unemployment (UU) and from employment to unemployment (EU) and the ratio of the inactive to the total population; year-on-year difference in the unemployment rate in percentage points.

Source: Authors' calculations based on quarterly aggregate labour market flows from the Labour Force Survey.

If a person becomes unemployed, we assume that his or her previous net work income is replaced by unemployment benefit, while the income of other household members and social income remain unchanged. The monthly amounts of unemployment benefit are determined by the individual's previous net work income and demographic characteristics (age). In particular, workers younger than 50 collect unemployment benefit for 5 months, those between 50 to 55 for 8 months, and those older than 55 for 11 months. The amount of the unemployment benefit equals 65 per cent of the previous net work income during the first and second month, 50 per cent in the next 2 months, and 45 per cent in the remaining period. The maximum amount of the benefit is set at 0.58 times the economy-wide average wage. In the remaining months of the year after the eligibility for unemployment benefit expires, we assume that net household income is topped up to the level of the subsistence minimum amount of the whole household if it is lower.[17]

While the non-work income of persons entering unemployment is determined using eligibility criteria, we have to assign a wage for non-workers who find jobs. This entry wage is predicted using the Heckman (1979) model, taking into account selection into employment. In particular, we estimate the following wage equation:

$$logw_i = \gamma x_i + u_{1i} \qquad (4)$$

where wi is the monthly net wage, xi is a vector of characteristics determining the wage wi (the same set of variables as in (3)) and u1i ~ N(0,σ). The wage wi is observed if

[17] For a more detailed description of the Czech tax and benefit system and full simulations of changes in net household income due to transitions between employment and unemployment, see Galuščák and Pavel (2012).

$$\delta x_i + u_{2i} > 0 \qquad (4')$$

where u2i ~ N(0,1) and corr(u1,u2) = ρ.[18] The wage and selection equations (4) and (4') are estimated jointly by maximum likelihood. The predicted log of the wage from (4) is retransformed into a level (see Cameron and Trivedi, 2009).[19,20]

After applying the relevant unemployment scenario as described in this subsection, we assign to each person a probability of being unemployed which is consistent with the target unemployment rate. For every possible combination of employment and unemployment for household heads and second adults within households, we calculate the household's net income NI and the resulting financial surplus FS as defined in (2), which we then use to assess whether the household in the given state is distressed or not. This is reflected in the values of the binary variables indicating distressed households.[21] The level of distress is calculated for each household as the average of these binary variables weighted by their probability of occurrence.[22]

3.3. Interest Rate Shocks

To apply the interest rate shock we are limited by the information on household debt that is available in our dataset. In particular, the dataset contains information on instalments by housing loans, consumer loans and other loans. As the interest rates are not available, they are approximated using general macroeconomic statistics. We assume that households pay their debts in monthly instalments, a simplification that largely corresponds to the observed facts. The average residual maturity is assumed to be 18 years for housing loans, 2 years for consumer loans and 5 years for other loans.[23] We further assume that in the long term, interest rate shocks affect all three loan categories, so the instalments are recalculated accordingly. In the short term, which we define as the 1-year horizon, we assume that 51.1 per cent of housing loans and all loans in the category of other loans are renegotiated, while interest rates on consumer loans are not affected within the 1-year horizon.[24,25] Before applying the interest rate shock,

[18] The identification of the model is based on nonlinearity in the selection equation in (4').

[19] Benczúr et al. (2012) estimate the effect of income taxation on labour force participation using the Hungarian Household Budget Survey. In the Heckman (1979) selection model they introduce gains to work, reflecting the fact that non-labour income accounts for lost transfers due to taking up a job. The same methodology is used in Galuščák and Kátay (2013) to compare the effects of the Czech and Hungarian tax and benefit systems on labour supply. We leave the use of their methodology for stress testing the Czech household sector for future research.

[20] The set of explanatory variables xi used in (4) and (4') is the same as in (3). Hence, we predict the probability of unemployment as unity minus the predicted values (4') in our simulations instead of the predicted values from (3). The use of predicted participation values from the Heckman selection model accounts for the wage equation in (4). Nevertheless, we leave the description of the unemployment probability model in this section as well as reporting its estimates in Section 5 for expository purposes.

[21] We assume that within households, potential transitions between labour market states are independent.

[22] This approach is equivalent to performing Monte Carlo simulations. Johansson and Person (2006) and Albacete and Fessler (2010) employ Monte Carlo simulations, as they consider the unemployment shock to affect employed individuals only, while unemployed individuals remain unemployed after the shock.

[23] The average weighted residual maturity for all loan types is thus set at 13 years.

[24] By long-term effects we mean full refixation of loans and by short-term effects we mean partial refixation.

[25] For housing loans, the most often used fixation periods are 1, 3 and 5 years. All interest rates in the first category of loans, one-third in the second category of loans and one-fifth in the last category are thus refixed within a 1-year period. If we assume that all three types of fixations are equally frequent, then on average 51.1 per cent of interest rates are

the residual principal for each household with debt is estimated by determining the present value of the annuity (which is equal to the instalment for every loan type). When the interest rate is increased, the corresponding annuity is determined by the present value method using the above-mentioned estimated value of the remaining principal. The new annuity value is then equal to the new value of the instalments for each loan type.[26]

3.4. Essential Expenditure Price Shocks

We assume that essential expenditure, defined in (2), may change due to a shock to prices of essential goods. While we take into account non-zero price elasticities of demand in the case of a partial shock to prices, we also account for demand effects due to income change when we consider a combined shock with an increasing unemployment rate in the stress testing scenarios.[27] The essential expenditures price shock is modelled using values of the demand elasticities for groups of essential goods taken from the available literature. In particular, we use the price and income elasticity estimates from Dybczak et al. (2010), which are reported in Table 1 for food, energy and health. Rental expenditures are assumed to be price and income inelastic.[28]

Table 1: Elasticities of Demand in Categories of Essential Goods (%)

	Price elasticity	Income elasticity
Food	-0.68	0.89
Energy	-0.96	0.59
Health	-0.72	0.84

Note: Uncompensated price (income) elasticities showing the percentage change in the quantity demanded if the price (income) increases by 1 per cent.
Source: Dybczak et al. (2010).

3.5. Combined Shocks and Macroeconomic Scenarios

We show the effects of the unemployment rate shocks combined with the short-term effects of the interest rate shock. The effects of these shocks are simulated with reference to the end of 2012 as a starting point. Finally, we also consider two scenarios of economic developments in 2013. The baseline scenario is taken from the CNB's Inflation Report II/2013 (CNB, 2013a), while the alternative scenario, which illustrates hypothetical adverse developments, is from the CNB's Financial Stability Report 2012/2013 (CNB, 2013b).

refixed within a 1-year horizon. As a robustness check, we show alternative results with a different ratio of refixed interest rates.

[26] We neglect the effect of increased capital income from deposits due to higher interest rates. According to aggregate statistics, the flows from deposits are relatively small compared to the outflows due to loan repayments. Moreover, interest rates on deposits are less sensitive to movements in the general interest rate.

[27] The effects of partial price shocks are rather short-term, so we neglect the potential transmission of higher prices into wages through collective bargaining.

[28] Rental expenditure is included in the other goods category in Dybczak et al. (2010), which besides rents consists of materials for the maintenance of dwellings and other services. The price elasticity is -0.25, while the income elasticity stands at 0.87. As the category of other goods is too heterogeneous, we assume that rents are price and income inelastic.

4. Data and Stylised Facts

We use the Household Budget Survey (HBS) datasets for 2010, 2011 and 2012 as the main data source. The HBS contains household-level data collected yearly by the Czech Statistical Office. The 2012 data contain 2,835 households, of which 1,053 were servicing at least one loan. Table 2 presents the average characteristics of households with and without debt in 2012. The information on debt distinguishes housing loans, consumer loans and other loans. Table 2 shows that 51.9 per cent of households with debt in 2012 were servicing housing loans. Households with debt on average have more household members, have more children, are younger and have higher net monthly income. On the other hand, indebted households face a lower specific unemployment rate than households without debt. The other rows in Table 2 show the average values of monthly instalments, essential expenditure and the financial surplus as defined in (2). The statistics reveal that households with debt have a larger financial surplus and higher essential expenditure than households without debt, but the ratio of essential expenditure to net monthly income is higher for households without debt (42 per cent) than for households with debt (37 per cent). The larger financial surplus among households servicing debt is due to higher net income and a lower specific unemployment rate.[29]

Table 2: Characteristics of Households With and Without Debt in 2012

	Households with debt	Households without debt
Number of households*	1,053	1,782
-- with mortgage*	51.9%	--
Number of persons*	2.8	2.1
Number of children*	1.0	0.5
Age of head*	44.8	54.8
Net income (CZK/month)	35,567	27,720
Specific unemployment rate*	4.0%	6.3%
Instalments (CZK/month)	4,796	--
Essential expenditure (CZK/month)	13,235	11,660
Subsistence minimum amount (CZK/month)	7,594	6,148
Financial surplus (CZK/month)	17,536	16,060

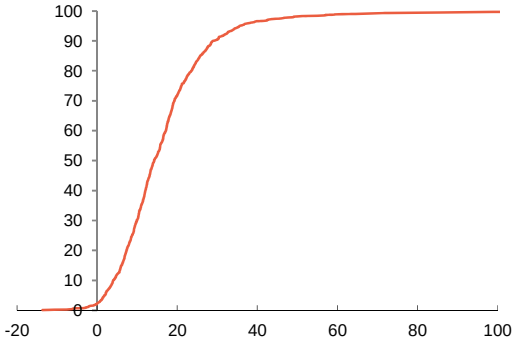
Note: *As of 31 December 2012.
Source: HBS 2012, Czech Statistical Office.

We define distressed households as those with a negative financial surplus as defined in (2). The sensitivity of the percentage of distressed households to the position of the distress threshold can be illustrated using the financial surplus distribution function (see Figure 2). At financial surplus values only just above zero, we observe a sharp increase in the slope of the distribution function. This suggests that with a positive distress threshold, there would be a relatively high risk of incorrectly determining the percentage of distressed households. Therefore, our preferred zero threshold lies in the band of low sensitivity of the percentage of distressed households to the financial surplus value, reducing the risk of inaccurate simulations.

[29] In Table 2 we also show the average values of the statutory subsistence minimum amount, which we use as an alternative definition of essential living costs.

Figure 2: Cumulative Distribution of Financial Surplus in 2012

(CZK thousands/month on x-axis; % on y-axis)



Note: Households with debt are included.
Source: HBS 2012; authors' calculations.

As the explanatory variables xi in (3), (4) and (4') we use year dummies and socio-demographic and financial variables contained in the HBS dataset, such as a dummy for household head, gender, education dummies, a dummy for spouse's education, age, dummies for spouse's labour market status, dummies indicating the presence of children (also interacted with gender), dummies denoting persons younger than 31 and persons older than 55, net income of other household members, dummies for regions, the amount of instalments (on consumer loans, mortgages and other loans) and dummies indicating ownership of durables (car, computer).

Our starting point for conducting simulations of the effects of shocks is the end of 2012, with which we compare the level of distress after 1–3 standard deviation shocks to unemployment, the interest rate and inflation of essential expenditure. For the interest rate shock we consider short-term effects with partial refixation of loans, and long-term effects where interest rates on all loans are renegotiated (see Section 3.3). Standard deviations are computed for the period January 2002–December 2012. One standard deviation equals 1.39 percentage point for the unemployment rate, 0.74 percentage point for the interest rate, and 1.73 percentage point for essential expenditure inflation. Assuming the normal distribution, the probability of a shock of the size of 1, 2 and 3 standard deviations is 15.9, 2.3 and 0.1 per cent respectively.[30]

Table 3 shows the unemployment rate, wage growth, inflation and interest rates in 2011 and 2012. The other two rows show the values for 2013; in particular, the baseline scenario is taken from the CNB's Inflation Report II/2013 (CNB, 2013a) and the alternative scenario – called Protracted Depression – is from the CNB's Financial Stability Report 2012/2013 (CNB, 2013b).[31] While the baseline scenario assumes a decline in economic activity in 2013 due to weak domestic demand and moderately recovering external demand, the alternative scenario is consistent with the assumption of a long-lasting and pronounced decline in economic activity due to low external demand and falling domestic consumption

[30] The assumption of normal distribution of shocked variables is not fully realistic, as the empirical distributions on the one hand are bell-shaped but on the other hand have heavier tails than the normal distribution. However, the probability of large shocks remains very low.

[31] In the stress testing results reported in CNB (2013b), the HBS dataset for 2012 was not available, so the 2012 data were approximated using wage and other income growth rates consistent with the available macroeconomic evidence. See Hlaváč, Jakubík and Galuščák (2013) for details on how they aged the 2011 HBS data into 2012.

and investment. The aim of the alternative scenario in CNB (2013b) is to test the resilience of selected segments of the Czech financial sector to alternative adverse developments.

Table 3: Macroeconomic Indicators and Scenarios (%)

Scenarios	Unemployment rate	Wages	Inflation	Interest rates
2011	6.7	2.4	1.9	6.6
2012	7.3	2.7	3.2	6.3
2013 Baseline	7.9	1.2	1.7	6.0
2013 Protracted Depression	8.5	-1.0	1.7	6.1

Note: Wages stands for average nominal wage growth. Inflation is the average of the year-on-year monthly CPI. Interest rates are average loan rates.

Source: The 2013 Baseline scenario is from Inflation Report II/2013 (CNB, 2013a) and the 2013 Protracted Depression scenario is from Financial Stability Report 2012/2013 (CNB, 2013b).

5. Results

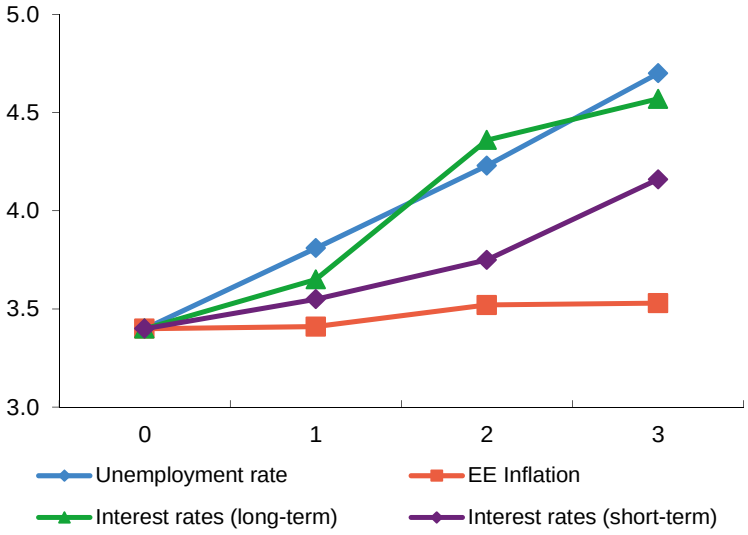
We estimate the Heckman selection model in (4) and (4') and use the estimates to predict the wages of non-workers. We also use the coefficient estimates from (4') to predict the probability of unemployment as unity minus the predicted value from (4'). Using the predicted values from the selection equation (4') takes into account the wage equation (4). Nevertheless, we also report estimates of the unemployment probit model in (3) for comparison. We estimate the models for employed and unemployed household heads and spouses using the HBS data in 2010–2012. The estimates are reported in Table A1 in the Appendix.

We examine the question of what influence the individual types of macroeconomic shocks under consideration have on household distress. Our starting point is the end of 2012, with which we compare the level of distress due to shocks to unemployment, the interest rate and inflation of essential expenditure of the size of 1–3 standard deviations. The results – in Figure 3 – suggest that the largest increase in the share of distressed households is observed due to the unemployment shock. The short-term effect of the interest rate shock is rather small, but the effect is higher for larger shocks of the size of 2–3 standard deviations. Nevertheless, in the short term (with partial refixation of loans) the interest rate shock has a smaller impact on household distress than the unemployment shock. If we consider the long-term effects of the interest rate shock, where all loans are renegotiated, the effect on household distress is higher for more sizeable shocks of 2–3 standard deviations and is comparable with the impact of the unemployment shock. Finally, the effect of the shock to prices of essential goods is small and increases only mildly for more sizeable shocks of 2–3 standard deviations. The effect of price shocks is mitigated by the use of non-zero price and income elasticities of demand (see Section 3.4).[32]

[32] We investigate how the results are sensitive to the definition of essential expenditure when we include expenditure on food, energy, health and rent. In Figure A1 in the Appendix we show the impact of the unemployment and interest rate shocks if we use the statutory subsistence minimum amounts as essential expenditure in the financial surplus defined in (2). We observe that the incidence of distress is lower in comparison with our baseline definition of essential expenditure, but the impact of shocks is very similar to the evidence in Figure 3. Next, we consider the alternative share of refixed loans in the short-term effects of the interest rate shock. The results – in Figure A2 in the Appendix – suggest that the percentage of distressed households is very similar at refixed rates of 50 per cent or less. On the other hand, a higher

Figure 3: Percentage of Distressed Households in Response to Macroeconomic Shocks

(% on y-axis; standard deviations on x-axis)



Note: Average ratio of distressed households relative to the end of 2012 in the event of shocks of the size of 1–3 standard deviations. Shocks to the unemployment rate, the interest rate (short-term and long-term effects) and essential expenditure (EE) are considered. Values at zero on the x-axis correspond to the starting point at the end of 2012.

Source: HBS 2011 and 2012; authors' calculations.

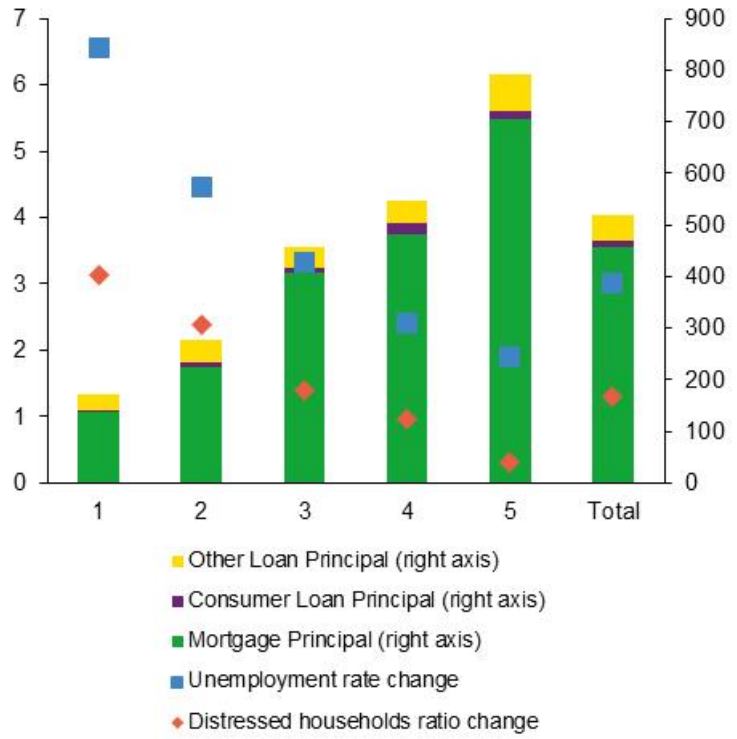
While in Figure 3 we show the average ratio of distressed households due to shocks, in Figure A3 in the Appendix we report the average percentage by income quintiles. The results suggest that households in the first income quintile are significantly more affected than other households under the interest rate shock and also in the case of a price shock of 2–3 standard deviations. The impact of the unemployment rate shock is also larger for the lowest income households, but this particular shock also sizeably affects other households below the median of the income distribution. In sum, the impact of the shocks considered is concentrated particularly on households in the lowest income quintile.

In order to illustrate the characteristics of households affected by adverse shocks, we compare in Figure 4 the change in the share of distressed households under the most sizeable unemployment rate shock with our estimate of the average residual principal along the income distribution, and the change in their specific unemployment rate. The results indicate that households in the first and second quintiles of the income distribution face the highest increase in financial distress, while they are also the most likely to be affected by higher unemployment. On the other hand, the indebtedness of those households is lower than that of other households, as indicated by the estimated mortgage principal. The results also show that the highest debt burden among Czech households is in mortgages.

share of distressed households is observed at a refixed rate of 50 per cent for the most sizeable shock of 3 standard deviations.

Figure 4: Reaction of Households to 3 Standard Deviation Shock to Unemployment Rate Versus Average Residual Principal by Income Quintiles

(percentage points; CZK thousands)



Note: Other loans are mainly leasing loans.
Source: HBS 2011 and 2012; authors' calculations.

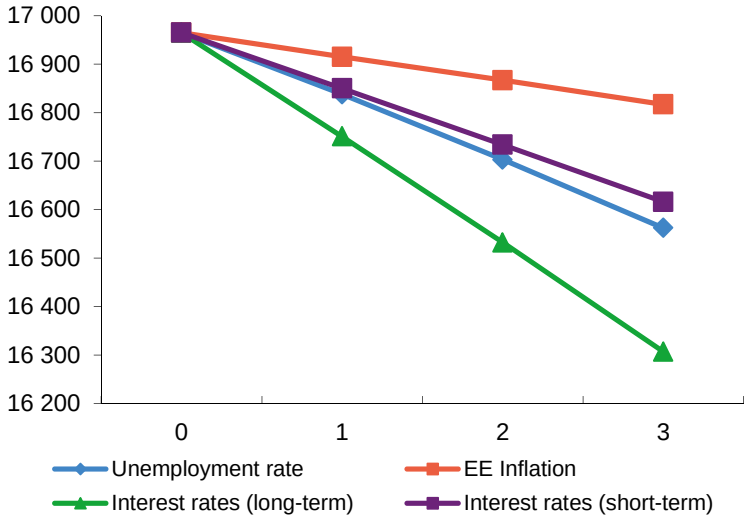
Figure 5 illustrates how the individual shocks affect the financial surplus. The most pronounced negative impact on household budgets is observed for the long-term effects of the interest rate shock. A smaller drop is identified for the effects of the unemployment rate shock and the short-term interest rate shock. The interest rate shock impacts mainly on higher-income households, which less often become distressed, while the unemployment rate shock largely affects lower-income households, which are closer to the zero threshold identifying household distress. This explains why we observe the highest fall in the financial surplus due to the (long-term) interest rate shock, while the impact on the incidence of distressed households is similar for the unemployment and (long-term) interest rate shocks. Finally, the effects of the essential expenditure price shock are very small compared to the effects of the other shocks.

In order to see the impact on the financial surplus for households in different parts of the income distribution, we calculate the financial surplus by income quintiles. The results of this examination – in Figure A4 in the Appendix – suggest that the absolute change in the financial surplus increases along the income distribution and is largest for households in the highest quintile for all the types of shocks we consider in this paper. Finally, we also check the robustness of the results for possible outliers. For this purpose we compare in Figure A5 in the Appendix the average and median financial surplus change in response to the shocks. The results indicate that the median changes in the financial surplus are less pronounced in most cases, but close to the average changes, so extreme financial surplus values do not drive the results significantly.

In Table 4 we show the effects of the unemployment rate shock combined with the short-term effects of the interest rate shock. While 3.4 per cent of households are distressed (with a negative financial surplus) under the no-shock situation, the share of distressed households increases to 4.0 per cent due to 1 standard deviation shocks, and to 4.6 and 5.5 per cent due to 2 and 3 standard deviation shocks.[33]

Figure 5: Average Financial Surplus in Response to Macroeconomic Shocks

(CZK/month on y-axis; standard deviations on x-axis)



Note: Average financial surplus relative to the end of 2012 in the event of shocks of the size of 1–3 standard deviations. Shocks to the unemployment rate, the interest rate (short-term and long-term effects) and essential expenditure (EE) are considered. Values at zero on the x-axis correspond to the starting point at the end of 2012.

Table 4: Percentage of Distressed Households in Response to Combined Shocks to Unemployment Rate and Interest Rate

Interest rate shock → Unemployment shock ↓	0	1	2	3
0	3.4	3.6	3.8	4.2
1	3.8	4.0	4.2	4.6
2	4.2	4.4	4.6	5.0
3	4.7	4.8	5.1	5.5

Note: Shocks of the size of 0, 1, 2 and 3 standard deviations of the unemployment rate and the interest rate (short-term effects). Values at zero correspond to the starting point at the end of 2012.

[33] The datasets contain weights which may be used for the estimation and aggregation of the results. The use of weights in the estimation and in the calculation of the aggregate indicators has a negligible effect on the results, so we rely on unweighted regressions and averages.

We compare the effects of the unemployment and interest rate shocks with the available evidence for other countries, in particular with Johansson and Persson (2006) for Sweden and with Albacete and Fessler (2010) for Austria. Both studies report the effects of shocks measured in percentage points rather than in standard deviations, hence we recalculate our results for shocks expressed in percentage points. In order to account for different no-shock incidence of household distress, we express the impact of shocks as the change in per cent from the no-shock scenarios. The results – in Table 5 – suggest that for the Czech Republic the household distress incidence increases by 8.8 per cent due to the 1 percentage point shock to the unemployment rate, while it rises by 17.6 and 26.5 per cent for larger shocks of 2 and 3 percentage points. The impact is much larger than in Sweden and Austria. We explain the difference by the fact that we include household heads as well as spouses in our estimation.[34] We believe that the omission of spouses (due to data availability) leads to underestimation of the effects of the unemployment rate shock in Johansson and Persson (2006) for Sweden and in Albacete and Fessler (2010) for Austria.

In Table 6 we compare both the short-term and the long-term impact of the interest rate shock. In the Czech Republic the incidence of distressed households increases by 5.9, 14.7 and 29.4 per cent at the 1-year horizon if the interest rate increases by 1, 2 and 3 percentage points, while for the long-term effects the incidence increases by 8.8, 38.2 and 47.1 per cent. We observe that the impact is similar to the effects reported for Austria, while the effects due to the interest rate shock are substantially lower in Sweden. The lower impact of the interest rate shock in Sweden may be due to a lower debt burden expressed as the interest ratio, which ranges from 3.9 to 5.7 per cent across the income quintiles, while in the Czech Republic the ratio is about twice as high.[35]

Table 5: Impact of Unemployment Rate Shock

	1	2	3
Czech Republic	8.8	17.6	26.5
Sweden	3.2	4.8	6.3
Austria	1.1	1.1	2.2

Note: Increase in the incidence of distressed households in per cent from the no-shock scenarios. The size of the shock is in percentage points. The results for the Czech Republic are from this paper, those for Sweden are from Johansson and Persson (2006) and those for Austria are from Albacete and Fessler (2010).

Table 6: Impact of Interest Rate Shock

	1	2	3
Czech Republic	5.9 (8.8)	14.7 (38.2)	29.4 (47.1)
Sweden	1.6 (4.8)	4.8 (12.7)	6.3 (15.9)
Austria	6.5 (9.8)	20.7 (29.3)	30.4 (41.3)

Note: Short-term effects of the interest rate shock (partial refixation of loans); long-term effects (full refixation of loans) in parentheses. Increase in the incidence of distressed households in per cent from the no-shock scenarios. The size of the shock is in percentage points. The results for the Czech Republic are from this paper, those for Sweden are from Johansson and Persson (2006) and those for Austria are from Albacete and Fessler (2010).

[34] It may also be due to differences in the value and duration of unemployment benefits in the three countries.

[35] Based on the statistics in Table 2, the ratio of instalments to net household income is 13 per cent. This is the upper bound for the interest ratio, as it contains the interest as well as principal repayments.

Next, we report the results on household distress for 2011, 2012 and two scenarios for 2013. The baseline scenario for 2013 is from the CNB forecast as of May 2013 (CNB, 2013a) and the alternative adverse scenario is from the CNB's Financial Stability Report 2012/2013 (CNB, 2013b). The results in Table 7 indicate that in 2013 the share of distressed households mildly increases from 3.4 to 3.6 per cent under the baseline scenario and to 3.8 per cent for the adverse scenario. The average financial surplus is insignificantly higher under the 2013 baseline scenario than in 2012 (in comparison with the change between 2011 and 2012). However, the average financial surplus is lower in 2013 than in 2012 under the adverse scenario of Protracted Depression.

While in Table 7 we report the average proportion of distressed households and the average financial surplus, the effects are different along the income distribution. Figure 6 depicts the distribution of households under distress by income quintiles.[36] The results indicate sizeable increases in household distress between 2011 and 2012, particularly among the two lowest quintiles. The level of household distress increases in 2013 under the baseline scenario, while the increases are larger for the adverse scenario. Overall, the results suggest that low-income households are more sensitive to stress scenarios, while the incidence of household distress is negligible in the top income quintile and is largely insensitive to the stress test scenarios.[37]

Table 7: Stress Test Results

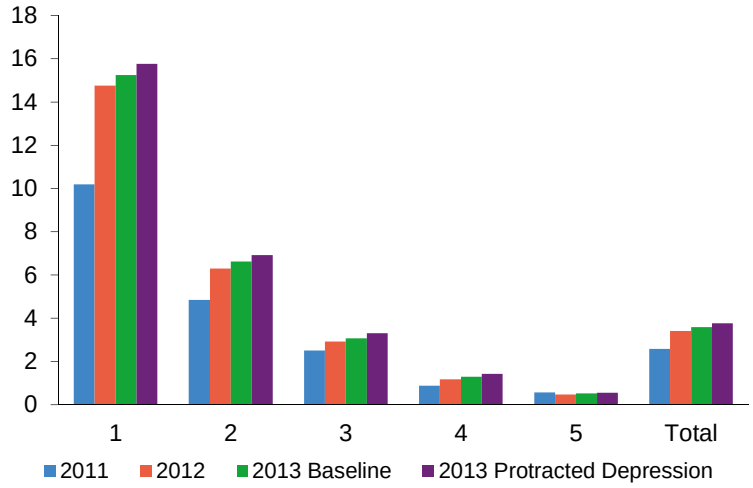
Indicator	2011	2012	2013	
			Baseline	Protracted Depression
Distressed households (%)	2.6 (1.44)	3.4 (1.99)	3.6	3.8
Average financial surplus (CZK/month)	15,917 (16,529)	16,965 (17,536)	17,079	16,617

Note: Simulations are used for all years. Observed values are reported in parentheses.
Source: HBS 2011 and 2012; authors' calculations.

[36] The quintiles are determined according to household income in the whole sample of households. Figure 6 shows households with debt only, so the number of households is not the same across quintiles.

[37] The results hold if we consider the percentage of distressed households with respect to all households (see Figure A6 in the Appendix).

Figure 6: Distribution of Distressed Households by Income Quintiles (%)



Note: Households with debt included. Simulations are used for all years.
Source: HBS 2011 and 2012; authors' calculations.

6. Conclusions

In this paper we develop a methodology for identifying financially distressed households, who may fall behind in servicing their debts. We denote distressed households as those whose financial surplus, defined as net household income minus loan instalments and essential living costs, is negative. Following Johansson and Persson (2006) and Albacete and Fessler (2010), we consider the effects of shocks to household budgets, particularly shocks to the unemployment rate and to the interest rate, while we also account for price shocks affecting essential living costs. The novelty of our approach lies in allowing for labour market transitions in both directions between employment and unemployment, and, thanks to data availability, in accounting for household heads as well as spouses within households. The results suggest that this improvement may lead to a higher response in the incidence of household distress to the unemployment rate shock than in comparable studies for Sweden (Johansson and Persson, 2006) and Austria (Albacete and Fessler, 2010). Accounting for spouses within households is important, as household heads usually experience lower labour market transitions. Furthermore, the impact of interest rate shocks is of similar magnitude as in Austria, while it is substantially lower in Sweden due to a much lower interest ratio.

Overall, the greatest impact on households' ability to pay their debts is observed for the unemployment rate shock. This is of about similar size to the long-term effect of the interest rate shock, where all loans are renegotiated at higher interest rates. On the other hand, the short-term effects of the interest rate shock, which are associated with only partial refixation of loans, are about half the size of the long-term effects. Next, price shocks to essential expenditure yield very small changes in financial distress incidence among Czech households. This result may be due to accounting for non-zero price and income elasticities of demand along the fact that we consider broader groups of essential expenditure than which are typical for essential living costs, weakening the effects of the price shock. We also describe the impact of individual shocks to the average financial surplus, and consider the effects of combined shocks to the unemployment rate and the interest rate.

We illustrate the use of our methodology for stress testing the private household sector under macroeconomic scenarios from the CNB's official forecast and from the CNB's Financial Stability Report. The results highlight the importance of analysing the impact of macroeconomic shocks on households using individual-level data, as the impact is substantially higher among lower-income households because they are more sensitive to adverse shocks. Our methodology may be used along with the currently employed CNB macroeconomic credit risk model as an alternative way of calculating households' average probability of default. This is a significant refinement of the previously used stress test approaches.

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Appendix

Table A1: Estimates of Unemployment Probit and Heckman Selection Models

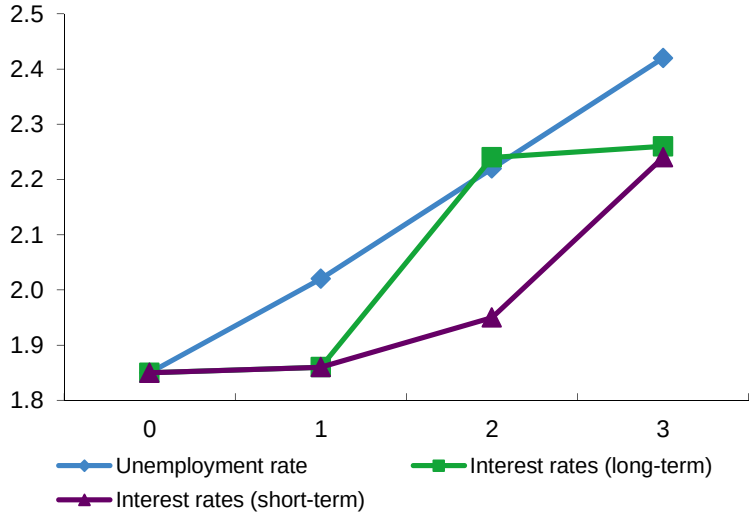
	Probit	Heckman	
	U	logW	Selection equation
Year 2010	-0.033	-0.005	0.016
	[0.053]	[0.008]	[0.060]
Year 2011	0.008	-0.018**	-0.023
	[0.043]	[0.008]	[0.059]
Household head	-0.244	0.138***	0.248*
	[0.183]	[0.020]	[0.139]
Gender	-0.149	-0.025	0.142
	[0.152]	[0.018]	[0.120]
Elementary education	1.292***	-0.456***	-1.314***
	[0.168]	[0.024]	[0.126]
Vocational education	0.442***	-0.346***	-0.456***
	[0.128]	[0.010]	[0.092]
Secondary education	0.226*	-0.156***	-0.271***
	[0.118]	[0.009]	[0.089]
Spouse's tertiary education	-0.144	0.033***	0.208**
	[0.118]	[0.010]	[0.101]
Age	-0.036	0.044***	0.028
	[0.051]	[0.005]	[0.040]
Age squared	0.06	-0.049***	-0.051
	[0.057]	[0.006]	[0.045]
Working spouse	-0.562***	0.034*	0.599***
	[0.182]	[0.020]	[0.151]
Unemployed spouse	-0.17	0.139***	0.17
	[0.237]	[0.026]	[0.179]
Inactive spouse	-0.590***	0.085***	0.548***
	[0.187]	[0.019]	[0.146]
Children <5	0.04	0.132***	0.004
	[0.153]	[0.012]	[0.124]
Children aged 6 to 9	-0.01	0.051***	0.062
	[0.133]	[0.012]	[0.134]
Children aged 10 to 14	0.199	0.046***	-0.194*
	[0.122]	[0.012]	[0.116]
Children <5 * Gender	0.585***	-0.304***	-0.634***
	[0.181]	[0.019]	[0.150]
Children 6 to 9 * Gender	0.669***	-0.144***	-0.726***
	[0.154]	[0.018]	[0.152]
Children 10 to 14 * Gender	0.276*	-0.100***	-0.272**
	[0.145]	[0.017]	[0.134]
Younger than 31	0.283*	-0.002	-0.336**

	Probit	Heckman	
	U	**logW**	**Selection equation**
	[0.168]	[0.019]	[0.149]
Older than 55	-0.145	0.066***	0.149
	[0.137]	[0.016]	[0.116]
Log of net income of other	0.090***	0.001	-0.103***
household members	[0.032]	[0.003]	[0.024]
Log of mortgage repayment	-0.027***	0.006***	0.031***
	[0.008]	[0.001]	[0.007]
Car	-0.544***	0.113***	0.573***
	[0.084]	[0.010]	[0.065]
Computer	-0.154*	0.062***	0.165**
	[0.090]	[0.010]	[0.070]
Constant	-1.55	8.827***	1.863**
	[1.158]	[0.122]	[0.891]
Observations	8754	8754	8754
Pseudo R2	0.173		
ρ		0.572***	
σ		0.282***	

Note: Estimates of the unemployment probit (3) and Heckman selection (4) and (4') models. Robust standard errors which allow for household-level intragroup correlation in brackets; *** p < 0.01, ** p < 0.05, * p < 0.1. Region dummies not reported.

Figure A1: Percentage of Distressed Households Due to Shocks –Alternative Definition of Essential Expenditure

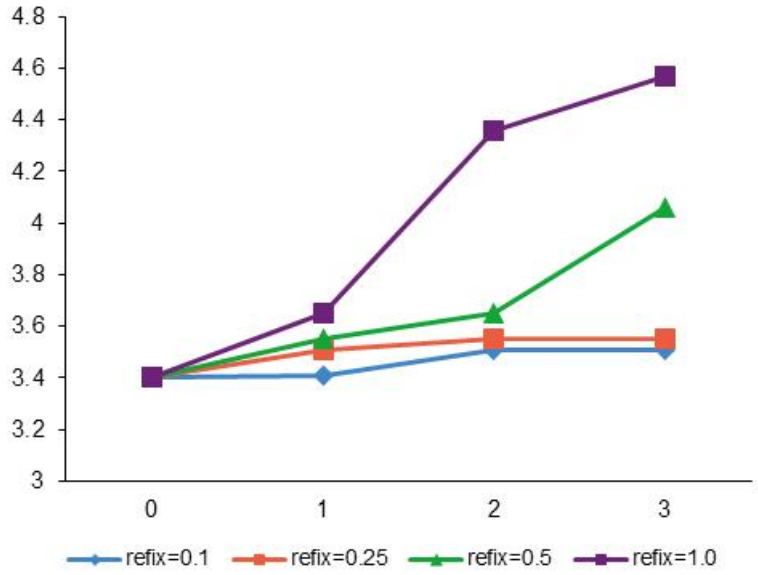
(% on y-axis; standard deviations on x-axis)



Note: See note to Figure 3. Essential expenditure defined as the minimum subsistence amount.
Source: HBS 2011 and 2012; authors' calculations.

Figure A2: Percentage of Distressed Households in Response to Interest Rate Shock – Alternative Ratio of Refixed Loans

(percentage points on y-axis; standard deviations on x-axis)

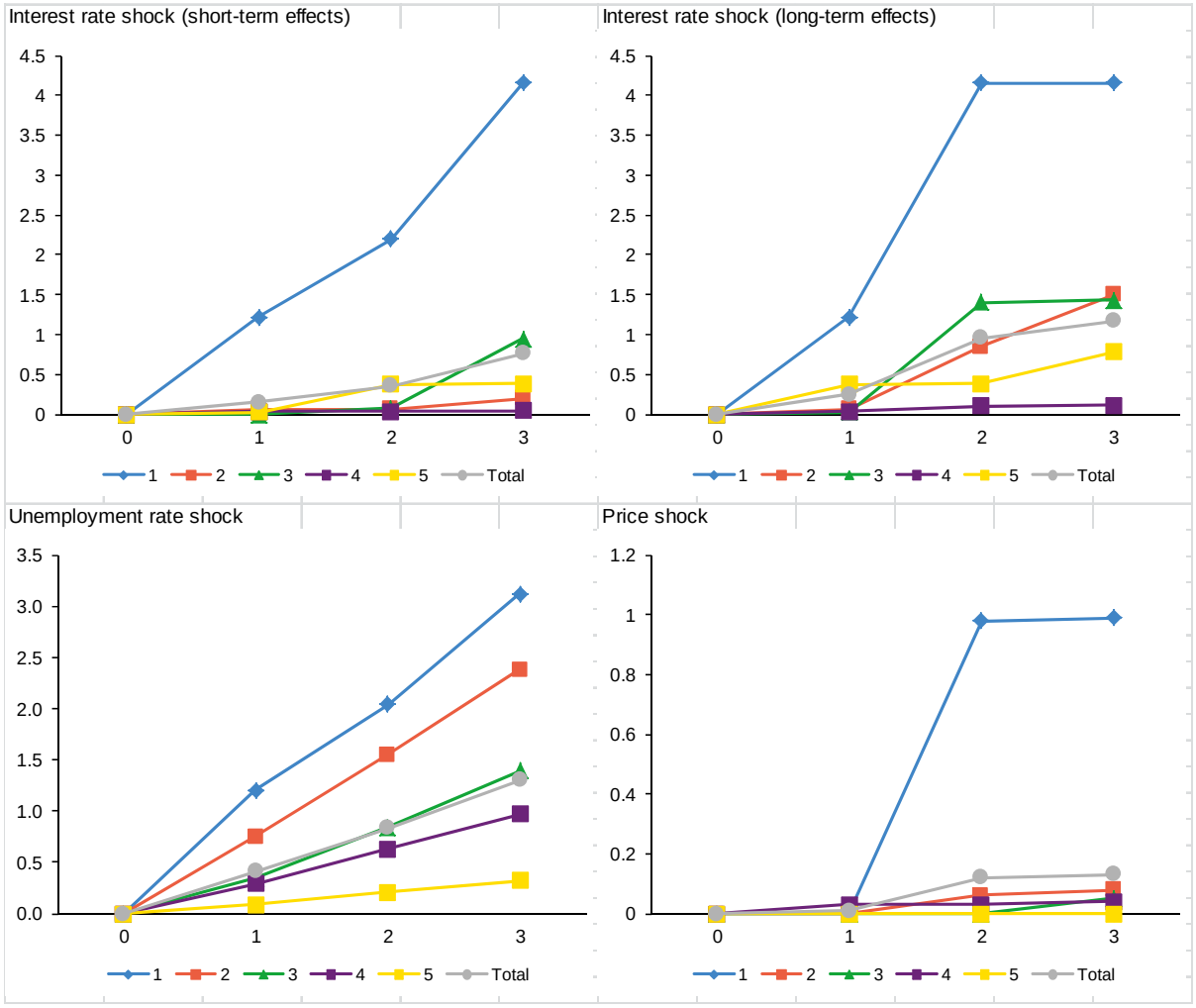


Note: Refix is the ratio of loans assumed to be refixed. The baseline results in Figure 3 are for refix = 0.511. The results for refix = 1 are the same as the long-term effects in Figure 3. Percentage of distressed households among households with a loan.

Source: HBS 2011 and 2012; authors' calculations.

Figure A3: Percentage of distressed households by income quintiles in response to shocks

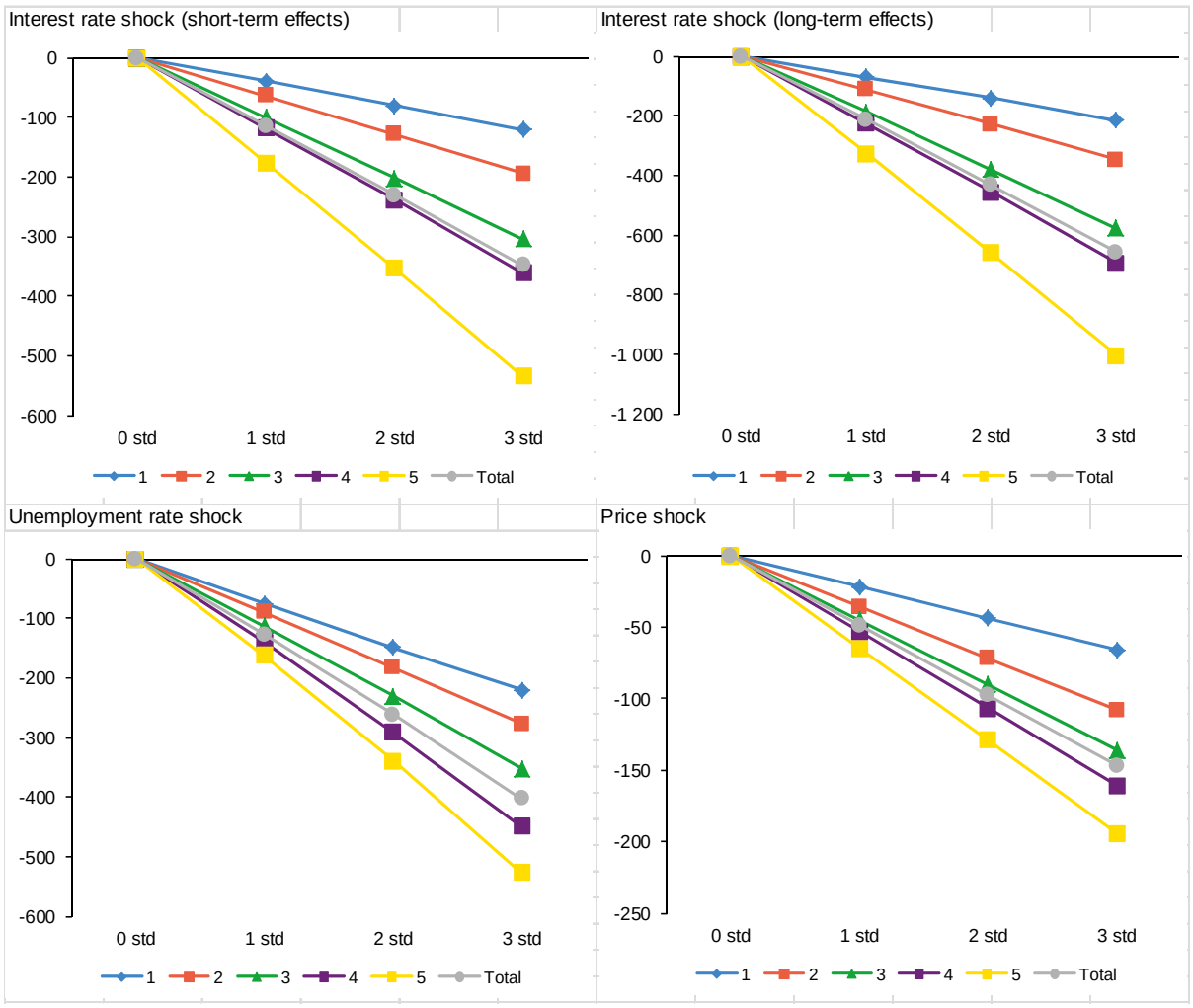
(percentage points on y-axis; standard deviations on x-axis)



***Note*:** Average percentage of distressed households among households with a loan.
Source: HBS 2011 and 2012; authors' calculations.

Figure A4: Change in Average Financial Surplus in Reaction to Shocks by Income Quintiles

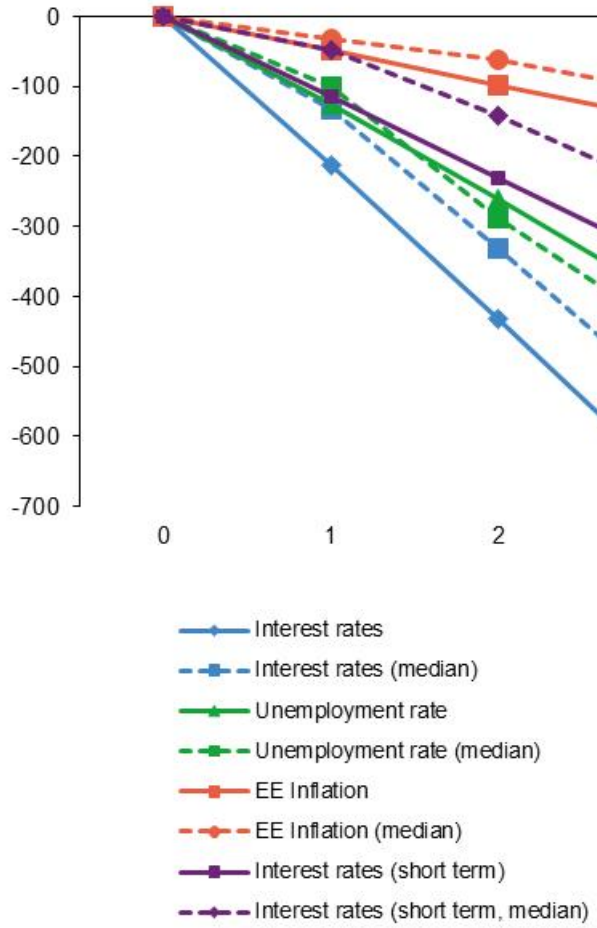
(CZK/month on y-axis; size of shock on x-axis)



Source: HBS 2011 and 2012; authors' calculations.
Note: Households with a loan are included.

Figure A5: Change in Average and Median Financial Surplus in Response to Macroeconomic Shocks

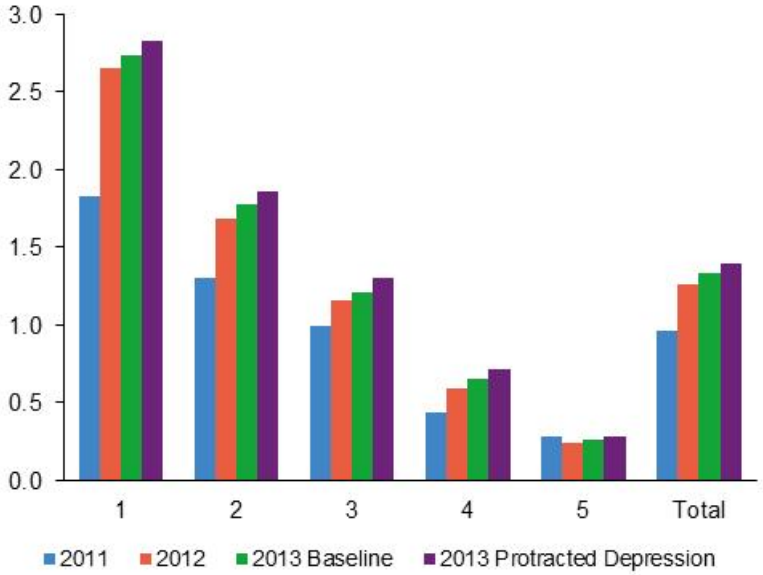
(CZK/month on y-axis; standard deviations on x-axis)



Note: EE stands for essential expenditure. The figure plots the average distress of households relative to the end of 2012 in the event of a 1–3 standard deviation shock to the individual variables. Zero on the x-axis therefore corresponds to the starting point at the end of 2012.

Source: HBS 2011 and 2012; authors' calculations.

Figure A6: Percentage of Distressed Households Among all Households by Income Quintiles (%)



Source: HBS 2011 and 2012; authors' calculations.

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