Mapping financial vulnerability in CESEE: understanding risk-bearing capacities of households is key in times of crisis

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A crisis of the real economy – like the current crisis caused by the coronavirus pandemic – and the countermeasures taken by countries worldwide can lead to a severe financial crisis if debtors turn out to be unable to pay back their debt. The support debtors need and the costs involved in providing it directly depends on the financial buffer households have and their general risk-bearing capacity. It is crucial to understand both aspects to be able to anticipate potential problems and prepare for mitigating their impact. Policies designed to mitigate the effects of income losses could benefit greatly from better knowledge of the exact nature of the nonlinearities involved. We analyze newly available microdata on households' balance sheets to examine financial vulnerability in Central, Eastern and Southeastern European (CESEE) countries and Austria. As Austrian banks have a high and increasing exposure in the region, households' risk-bearing capacities in CESEE are an important factor in determining credit risks of the banking sector in Austria. The Household Finance and Consumption Survey (HFCS) allows us to study the general indebtedness of households as well as borrower-level vulnerability in eight CESEE countries and compare them to Austria. While the share of households owning their homes is comparably large in these countries, the share of households holding mortgage debt is not particularly large. Uncollateralized debt levels, by contrast, vary greatly across the region, and some of the countries show rather high levels of loan-to-value ratios, which point to more generous credit standards in mortgage lending. The debt service-to-income ratio >40% vulnerability measure points toward households in Croatia, Lithuania, Slovenia and Hungary being particularly vulnerable. Subtracting the assets of vulnerable households from their debt reveals that the levels of potential losses for banks are generally low. The highest loss given default estimates are obtained for Slovenia, Hungary and Lithuania. Furthermore, we use a machine learning approach to reweight the data, thereby decomposing the observed differences between CESEE and Austria into one part that can be explained by observable household characteristics and a remainder, which might be linked to banks' different treatment of similar clients in different countries. The different directions of the effects of the reweighting approach across countries indicate that there is no typical household structure that suggests a high level of vulnerability as different types of households are vulnerable across countries. One important lesson from this crisis is to make sure that better data are available to policymakers (e.g. registers covering the loans of households to the necessary degree) so that research does not have to rely on survey data alone to analyze households' risk-bearing capacities and, hence, we are better prepared for the next crisis.

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Since the financial crisis of 2008-09, household indebtedness has been a major concern among researchers that try to understand the role of households in financial stability on the one hand and policymakers and central bankers that seek to regulate

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or steer mortgage markets in order to prevent potential future turmoil on the other. Especially the role of low interest rates, mortgage markets, household indebtedness and rising real estate prices are of great interest. The impact of the current COVID-19 crisis on the real economy has also rekindled concerns about nonperforming loans and credit risk in general.

These concerns stand in sharp contrast to the limited amount of data we have to analyze these important relationships. At the beginning of the crisis of 2008–09, for most countries, including Austria, there was neither a credit register for loans to households nor any type of survey data covering the information necessary to analyze the topic with the rigor and scrutiny it deserves. Unfortunately, even now, ten years later at the beginning of the COVID-19 crisis, we still do not have credit registers covering, to the necessary degree, the loans of households. What we do have is the Household Finance and Consumption Survey (HFCS), which gathers information on the balance sheets of households in the euro area and some other European countries. It is still the only dataset which allows us the comparative cross-country analysis of household indebtedness.

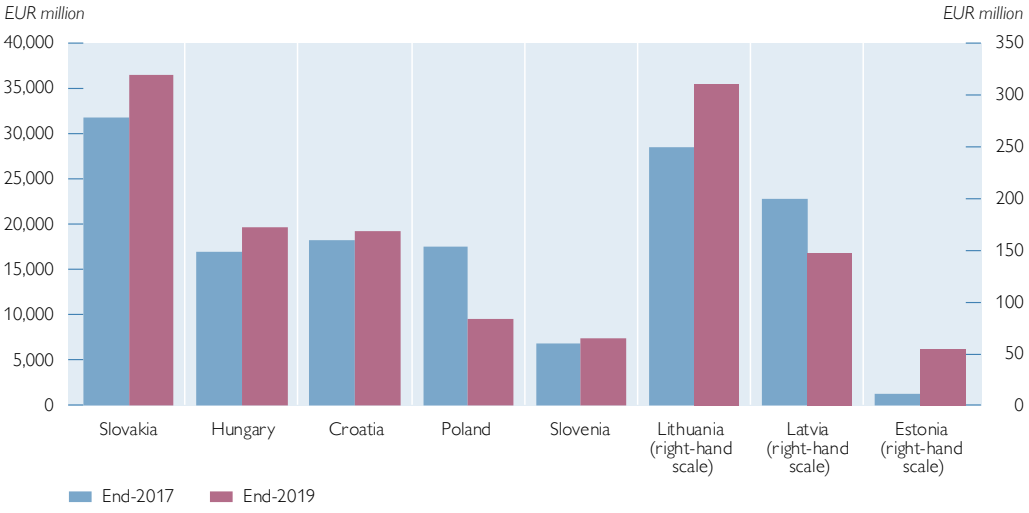
The Austrian banking sector is very exposed to economies in Central, Eastern and Southeastern Europe (CESEE). At end-2019, the exposure[2] of domestically controlled banks to CESEE amounted to some EUR 250,000 million, which is 8% higher than at end-2017. Taken together, the eight CESEE economies analyzed in this study (Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia) account for an exposure of over EUR 92,000 million; the exposure is highest in Slovakia (EUR 36,427 million), followed by Hungary (EUR 19,677 million) and Croatia (EUR 19,234 million), see also chart 1.

We employ recently available data of the third wave of the HFCS and focus on household indebtedness in Austria compared to eight CESEE countries, namely

Chart 1

Exposure of Austrian banks in CESEE

Measured by the ultimate risk of all banks



Source: OeNB.

[2] *The exposure is measured by the ultimate risk of the domestically controlled banks.*

Estonia, Croatia, Hungary, Lithuania, Latvia, Poland, Slovakia and Slovenia,[3] to achieve our threefold objective: First, we describe indebtedness by looking at the extensive and intensive margins of different forms of debt across countries. Second, we calculate measures of risk-bearing capacities and identify vulnerable households in the countries we analyze. We calculate how much debt – before and after deducting different assets – is held by such potentially vulnerable households. Third, we ask to what degree the observed cross-country differences might be due to differences in household characteristics across countries. Or put differently, we compare apples with apples, that is, households with similar households, and have a look at the remaining differences.

As most major Austrian banks are very active in CESEE, households' risk-bearing capacities in the region are an important factor in determining credit risks of the Austrian banking sector.

We are aware of two studies presenting a comparable cross-country vulnerability analysis for the CESEE region: Fessler, List and Messner (2017) used the second wave of the HFCS, which included neither Croatia nor Lithuania, and Riedl (2019) examines household vulnerability for ten CESEE countries using the OeNB Euro Survey by focusing on the debt service-to-income ratio. However, due to data limitations, Riedl (2019) does not consider the value of households' assets in this analysis.

The remainder of the paper is structured as follows: As the COVID-19 crisis was unfolding just as we were finishing this paper, we added a box which follows this introduction and provides additional statistics on households' risk-bearing capacities that we consider especially relevant in the crisis. In section 1, we introduce the data. Section 2 provides an overview of household indebtedness. In section 3, we calculate and compare different measures of households' risk-bearing capacities and identify vulnerable households and their debt. In section 4, we apply a reweighting technique to decompose the results in a way that allows us to filter out cross-country differences due to different household compositions.

[3] *For Croatia and Lithuania, this is the first HFCS wave that allows such an analysis.*

Box 1

COVID-19 and household vulnerability in CESEE

The COVID-19 crisis started as a health crisis, and the measures taken to fight the pandemic have turned it into a crisis of the real economy. A large part of the economy is in shutdown and will only restart very slowly. In this situation, it may be helpful to know more about the ability of households to serve their debt with less income and how this ability differs across countries. We can use HFCS data to, first, calculate the ratio of liquid assets (deposits + mutual funds + bonds + value of non-self-employed business + shares + managed accounts) divided by the monthly debt service of indebted households. This gives an indication of how many months households could serve their debt by only using their liquid assets. Second, we assume income shocks of 10%, 20%, 30%, 40% and 50% and examine how many households would have a debt service-to-income ratio higher than 40% given these new income figures. Both ad hoc calculations should give an indication of how the ability of households to serve their debt differs between countries. It is rather obvious that these are neither the ideal data nor the ideal tools to answer such questions. However, unfortunately, the necessary data and tools (such as up-to-date credit registers including the universe of credits as well as information on households) have not been set up since the last crisis hit in 2008.

Table 1 shows the ratio of liquid assets to the monthly debt service of indebted households. The first column shows the ratio of the totals, while the second column shows the median of the household level ratios. As the distribution of liquid assets is very skewed, the two figures are very different. The median ratio is about 13 in Austria, which means that the median indebted household could serve its debt for 13 months if all liquid assets could be used. This figure is substantially lower in all other countries. In Poland and Slovakia, it is about six months, in Croatia, Lithuania and Slovenia, it is below one month. In these countries, a large part of indebted households hardly hold any liquid assets at all. Aggregate statistics look very different. In all countries, total liquid assets of indebted household cover several years of debt service. This mirrors the fact that it is mostly households with lower debt service that also have lower amounts of liquid assets.

Chart 1 shows the share of vulnerable households defined by a debt service-to-income ratio higher than 40% – a common measure in the analysis of household vulnerability. Note that the HFCS only included

Table 1

Indebted households: liquid assets to monthly debt service

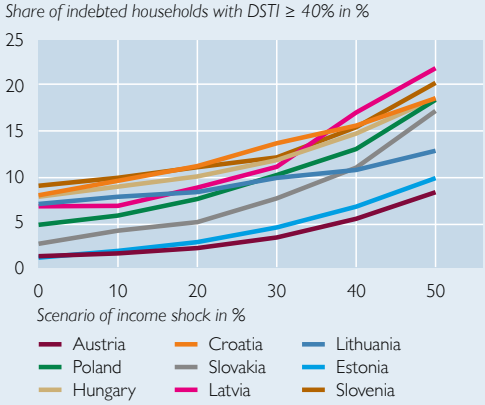
	Ratio of totals (aggregate level)	Median ratio (household level)
Austria	298.5	11.3
Estonia	118.9	2.1
Croatia	70.2	0.0
Hungary	207.2	1.3
Lithuania	93.9	0.3
Latvia	32.0	1.7
Poland	105.6	6.2
Slovenia	119.7	0.5
Slovakia	84.0	5.3

Source: Eurosystem HFCS 2017.

Note: Ratio of totals (aggregate level): defined as the sum of all liquid assets of indebted households divided by the monthly debt service total of these households. Median ratio (household level): the ratio of liquid assets to monthly debt service is first calculated at the household level. Then the median of these ratios is taken. The numbers can therefore be interpreted as liquid assets in months of debt service.

Chart 2

Financially vulnerable households conditional on different income shocks in CESEE



Source: Eurosystem HFCS 2017.

Note: Income is measured as gross income.

comparable measures of gross income. This is not a problem in this exercise as we are only interested in how patterns differ across countries if we decrease gross income. We only want to stress a point we deem very important in designing policies to mitigate the current crisis: One can clearly see the nonlinearities involved. The share of vulnerable households increases in a nonlinear way assuming a shock on income. Policies designed to mitigate the effects of income losses could benefit greatly from a better knowledge of the exact nature of such nonlinearities. There might be hardly any problems for households up to a certain degree but from then nonperforming loans might suddenly increase dramatically.

1 Data

We use data of the third wave of the HFCS, which gathers household balance sheet data, or, in other words, data on the assets and liabilities of households in the euro area as well as in Croatia, Hungary and Poland. The third wave was released in March 2020. The HFCS includes population weights based on design, nonresponse and poststratification weights. We use population weights for all calculations in this paper. Additionally, the HFCS uses a multiple imputation procedure based on chained equations to correct for partial response refusal. We use all five imputations and apply Rubin's Rule for all calculations in this paper (Little and Rubin, 2019). As we are only concerned with Austria and eight CESEE countries, we show some basic information about the different HFCS surveys in these countries in table 2.

Table 2 shows that the fieldwork in selected countries took place from 2016 to 2018. The net sample size ranges from 1,249 in Latvia, which represent about 840,000 households, to 5,890 households in Poland, which represent over 13 million households. Response rates differ substantially between countries, from 31.4% in Hungary to 77.2% in Estonia. The common survey mode is a computer-assisted personal interview (CAPI). Some countries additionally use other survey modes. In Poland, all interviews take place as paper and pencil interviews. More detailed information about the data can be found in the methodological notes (see HFCN,

Table 2

Survey information: HFCS – third wave

	Fieldwork	Net sample size	Response rate (%)	Number of households	Mode
Austria	2016/2017	3,072	49.8	3,933,967	CAPI
Estonia	2017	2,679	77.2	590,739	CAPI
Croatia	2016	1,357	35.8	1,495,082	CAPI
Hungary	2017	4,233	31.4	4,004,215	CAPI
Lithuania	2017/2018	1,730	47.1	1,286,924	CAPI (97.3%), PAPI (0.9%)
Latvia	2017	1,249	45.3	836,810	CAPI (95.4%), CATI (4.4%), PAPI (0.2%)
Poland	2016	5,890	52.8	13,374,992	PAPI
Slovenia	2017	2,035	38.1	824,618	CAPI
Slovakia	2017	2,181	56.2	1,852,059	CAPI

Source: Eurosystem HFCS 2017.

Note: CAPI = computer-assisted personal interview
CATI = computer-assisted telephone interview
PAPI = paper and pencil interview

2020). As already mentioned above, the HFCS is still the only dataset which allows a comparative cross-country analysis of household indebtedness. For measurement issues such as coverage and underreporting problems of wealth surveys, see Fessler et al. (2016).

2 What does household debt in CESEE look like?

Households hold debt for many different reasons. The largest amounts of debt are usually connected to homeownership. This is usually collateralized debt, with the home serving as collateral. Less common are other collateralized loans used for business purposes of the self-employed or loans to finance other real estate. Besides such collateralized loans, households also have uncollateralized forms of debt. Often, these are loans to finance furniture or a car. Sometimes they are also used for debt consolidation and covering living expenses. Overdrafts on current accounts is another form of uncollateralized debt that is quite common in some European countries, such as Austria. Unlike in the U.S.A., only few households in Europe use credit cards to hold debt. By contrast, a very common form of holding debt are private loans provided by family members or friends, which, however, pose no direct threat to the banking system.

Household indebtedness can be problematic for both, the indebted households and the banking sector providing the loans. As we will see, uncollateralized debt is more common among lower income and lower wealth households, while collateralized debt is more common among higher income and higher wealth households. Also, the sum of collateralized debt is by far larger than the sum of uncollateralized debt, which makes the former much more important for financial stability.

Table 3

Assets and liabilities: extensive margins

	Austria	Estonia	Croatia	Hungary	Lithuania	Latvia	Poland	Slovenia	Slovakia
	% of households								
Real assets	**86.2**	**87.4**	**94.0**	**92.3**	**96.7**	**84.3**	**91.2**	**94.0**	**95.6**
Household main residence	45.9	75.3	85.3	84.0	93.2	72.7	79.3	76.3	88.8
Other real estate	13.0	32.6	22.7	22.0	21.9	36.6	24.0	28.1	28.0
Financial assets	**99.7**	**99.6**	**81.9**	**82.1**	**90.7**	**89.1**	**89.1**	**95.2**	**92.1**
Deposits	99.7	99.6	80.9	81.0	90.4	87.7	84.9	94.8	91.6
Funds, stocks, bonds	13.5	6.7	6.4	8.4	3.0	0.9	5.8	11.2	6.5
Other financial assets	1.1	0.8	0.5	0.0	0.5	0.0	0.7	0.8	0.2
Debt	**32.7**	**48.0**	**40.7**	**31.6**	**26.1**	**39.6**	**40.5**	**32.2**	**36.6**
Collateralized debt	*16.5*	*20.9*	*9.0*	*17.4*	*11.7*	*13.8*	*15.0*	*9.1*	*20.7*
Household main residence	15.6	18.1	8.6	15.8	10.4	11.5	13.2	8.2	19.6
Other real estate	1.4	3.7	0.4	2.1	2.0	3.0	2.2	1.4	1.4
Uncollateralized debt	*20.3*	*40.3*	*35.8*	*20.1*	*18.5*	*32.9*	*32.1*	*26.9*	*21.4*
Overdraft	11.8	7.2	27.0	7.2	11.1	2.8	0.0	13.1	4.0
Credit card	0.7	23.7	5.8	4.3	4.0	2.1	15.6	6.2	3.3
Other uncollateralized loans	7.4	24.2	10.2	9.7	4.3	28.9	21.3	14.1	14.5
Private loans	4.1	2.8	2.8	4.3	3.0	4.1	0.0	2.2	4.7
Net wealth	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Net sample size	3,072	2,679	1,357	4,233	1,730	1,249	5,890	2,035	2,181
Households represented	3,933,967	590,739	1,495,082	4,004,215	1,286,924	836,810	13,374,992	824,618	1,852,059

Source: Eurosystem HFCS 2017.

Uncollateralized household debt often is a problem for the households that hold it, as it is sometimes a substitute for missing income – especially in the case of overdrafts and credit card debt. But it is hardly a threat to financial stability mainly because of its relatively low volume. Household debt can become a problem for banks and financial stability if the share of debt held by households potentially vulnerable to economic shocks is large. Additional problems may occur if the collateral is likely to be overvalued and loss given default might be higher than anticipated because the realized value of collateral was lower than expected. Especially in times of potential housing bubbles this phenomenon can be of substantial importance: if a crisis hits, it is quite likely that housing supply increases rapidly – due to foreclosures – while housing demand tends to be rather low.

Table 3 shows extensive margins for assets and liabilities in Austria and the CESEE countries under review. With regard to assets, we distinguish between real assets and financial assets. On the other side of the household balance sheet, we subdivide debt into collateralized debt and uncollateralized debt. In Austria, 86.2% of households hold real assets, which is a rather low share compared to CESEE countries, where between 84.3% (Latvia) and 95.6% (Slovakia) of households hold real assets. This is partially due to the relatively low shares of households who own their main residence in Austria (45.9% compared to over 75% in all CESEE countries) and households who additionally own other real estate (13% in Austria compared to over 20% in all CESEE countries). The share of households owning financial assets also differs across countries, from 81.9% in Croatia to 99.7% in Austria. However, deposits are the most common form of financial asset in every country. The differences in owning other financial assets, such as mutual funds, stocks or bonds, are rather large. In Latvia, 0.9% of households hold these kinds of assets compared to 13.5% of households in Austria.

Looking at households' liabilities, we see that extensive debt margins range from 26.1% in Lithuania to 48.0% in Estonia. In Austria, about one-third of households are in debt. More precisely, 16.5% of Austrian households hold collateralized debt and 20.3% hold uncollateralized debt. The former lies between the lowest value in CESEE (9.0% in Croatia) and the highest one (20.9% in Estonia). Furthermore, using their main residence as collateral is the usual framework for households that hold that kind of debt. Using other real estate as a collateral is rather unusual: less than 4% of households do that in these countries, albeit in CESEE countries, more than 20% of households have that kind of collateral. The occurrence of uncollateralized debt differs notably across countries, from 18.5% in Lithuania to over 40% in Estonia (Austria: 20.3%). Moreover, we see a heterogenous pattern of uncollateralized debt in these countries. In Croatia, for example, overdrafts are the most common type of uncollateralized debt (27% of household hold overdraft debt), followed by other uncollateralized loans (i.e. consumer credits, at 10.2%) and credit card debt (5.8%). In Latvia and Estonia, on the other hand, other uncollateralized loans are the most common type, with 28.9% and 24.2%, respectively, of households holding such debt. More than 20% of Estonian households also hold credit card debt, which is the highest figure for this type of debt in CESEE. Private loans range from 0% in Poland to 2.2% in Slovenia and 4.7% in Slovakia.

Table 4

Assets and liabilities: intensive margins

	Austria	Estonia	Croatia	Hungary	Lithuania	Latvia	Poland	Slovenia	Slovakia
	Conditional medians in EUR thousand								
Real assets	**120.8**	**60.0**	**69.8**	**39.4**	**48.4**	**29.9**	**67.3**	**97.4**	**73.9**
Household main residence	250.0	55.5	66.2	36.5	40.0	25.5	61.0	98.0	70.0
Other real estate	123.7	30.0	20.0	22.7	20.7	15.0	27.6	38.4	16.6
Financial assets	**15.5**	**2.8**	**0.5**	**1.1**	**1.0**	**0.4**	**3.7**	**1.4**	**2.8**
Deposits	12.8	1.9	0.3	0.9	0.6	0.2	2.8	1.0	2.0
Funds, stocks, bonds	15.0	3.8	2.2	8.0	4.6	0.9	2.6	4.3	4.6
Other financial assets	10.0	1.2	18.7	0.0	11.0	0.0	0.9	5.0	1.2
Debt	**17.1**	**4.9**	**2.2**	**5.5**	**5.7**	**3.0**	**2.3**	**5.9**	**11.4**
Collateralized debt	*64.6*	*29.9*	*20.0*	*11.4*	*23.4*	*22.1*	*25.3*	*36.4*	*31.7*
Household main residence	64.8	28.2	20.0	11.3	26.7	23.7	24.8	35.6	30.8
Other real estate	50.8	29.2	16.4	13.0	9.7	21.5	22.6	30.0	29.2
Uncollateralized debt	*2.3*	*1.3*	*1.6*	*1.0*	*1.0*	*1.3*	*0.6*	*2.2*	*2.0*
Overdraft	0.8	0.0	0.8	0.5	0.6	1.0	0.0	0.9	0.3
Credit card	0.4	0.5	0.4	0.5	0.5	0.5	0.2	0.3	0.3
Other uncollateralized loans	8.6	2.1	4.5	1.3	1.7	1.3	1.1	5.4	2.4
Private loans	4.0	1.3	2.6	1.6	6.1	1.5	0.0	4.6	3.0
Net wealth	**82.7**	**47.7**	**61.5**	**35.9**	**45.9**	**20.5**	**60.5**	**91.6**	**70.3**

Source: Eurosystem HFCS 2017.

Table 4 shows intensive margins of households' assets and liabilities in the form of conditional medians. From extensive margins (table 3) we know that uncollateralized debt is more common than collateralized debt in the countries analyzed. However, with regard to financial stability, the absolute values of collateralized debt are usually much higher than those of uncollateralized debt. This is also the case in these countries. Whereas conditional medians of debt in general range from EUR 2,200 in Croatia to EUR 17,100 in Austria, conditional medians of collateralized debt are much higher than conditional medians of uncollateralized debt. More precisely, the factor ranges from 12 (Hungary) to 41 (Poland). Since the most common collateral is the household main residence (HMR), one should compare conditional medians of HMRs and the collateralized debt secured with it. In Latvia, these intensive margins are closest to each other (HMR conditional median: EUR 25,500, debt collateralized by HMR conditional median: EUR 23,700). In every other country, however, the conditional medians of debt collateralized by HMR are about half or less compared to the conditional medians of HMR. This might be an indicator that household debt in these countries is fairly well secured. However, these two medians do not necessarily represent the same household. We can get more precise results by looking at the joint distribution of assets and liabilities, which is what we do in the next section.

3 How vulnerable are indebted households?

There are several measures to identify potentially financially vulnerable households (see e.g. Albacete and Fessler, 2010; Albacete and Lindner, 2013; Albacete et al., 2014; Ampudia et al., 2016; or Bankowska et al., 2017). The debt-to-asset ratio indicates the amount of debt a household can pay back with its assets. Since these assets are typically households' main residences, which are not easily transferable,

the debt-to-asset ratio considers the household's need to deleverage in the medium and long run. We define it as:

$$DA_i = \frac{D_i}{A_i} ,$$

where D_i is the household's total debt and A_i are the household's total gross assets (excluding public and occupational pension plans).

The debt-to-income ratio indicates the amount of debt a household can pay back in terms of its annual income. It does not consider loan maturities. We define the debt-to-income ratio as:

$$DTI_i = \frac{D_i}{I_i},$$

where I_i is the household's total gross income.

The debt service-to-income ratio, on the other hand gives the relation between annual debt payments and income. We define it as

$$DSTI_i = \frac{DS_i}{I_i},$$

where DS_i is the debt service of an indebted household per month and I_i is the household's total gross income per month (total gross income per year divided by 12). This ratio reflects short-term debt commitments and considers loan maturities and interest rate levels as well. Furthermore, we calculate the debt service-to-income ratio excluding those households that have only credit card or credit line/overdraft debt, as repayment is not collected in the data for these two types of debt. Lastly, the loan-to-value ratio (LTV), which is similar to the debt-to-asset ratio, gives the relation between the value of a household's main residence-backed mortgages $DHMR_i$ (a type of debt) and the current value of the household's main residence $VHMR_i$. Note that this ratio is of interest particularly in CESEE, where the rate of homeownership is relatively high, especially in comparison to Austria. We define it as:

$$LTV_i = \frac{DHMR_i}{VHMR_i}$$

Table 5

Potentially vulnerable households according to different measures

	Austria	Estonia	Croatia	Hungary	Lithuania	Latvia	Poland	Slovenia	Slovakia
	% of indebted households								
Debt-to-asset ratio ≥ 0.75	15.8	13.8	11.0	13.9	10.1	17.3	9.6	11.2	12.8
Debt-to-income ratio ≥ 3	7.5	5.4	12.5	7.4	19.0	5.6	6.1	9.8	10.8
Debt service-to-income ratio ≥ 0.4	1.6	1.4	8.1	8.0	7.2	6.9	5.0	9.1	2.9
Debt service-to-income ratio ≥ 0.4 *(households with debt payments)*	2.3	1.9	17.7	10.2	13.1	7.4	6.0	13.3	3.3
Loan-to-value ratio ≥ 0.75 *(households with mortgage on HMR)*	7.2	17.4	13.6	14.6	19.6	15.4	14.6	9.3	21.4
DTA ≥ 0.75 & DTI ≥ 3 & DSTI ≥ 0.4	0.3	0.1	1.2	2.0	1.0	1.0	0.4	0.9	0.6
Expenditure higher than income	17.6	11.3	28.8	17.1	12.0	13.8	22.6	11.3	23.4
Bills not paid *(households with expenditure > income)*	1.3	0.8	5.7	5.6	4.0	3.5	1.7	3.0	2.8

Source: Eurosystem HFCS 2017.

Table 5 shows the share of indebted households that surpass certain critical thresholds for these ratios and are therefore classified as potentially financially vulnerable. In Austria, 15.8% of households are potentially financially vulnerable according to the debt-to-asset ratio ≥ 0.75 measure, which is the second largest share among all countries under review, after Latvia (17.3%). The share of households that have a loan-to-value ratio greater than 0.75, on the other hand, is lowest in Austria (7.2%). This might also be due to lower homeownership rates in Austria compared to CESEE. We observe the highest share of households with a loan-to-value ratio above 0.75 in Slovakia at 21.4%. Some of these households might be forced to deleverage in the medium and long term. In the short term, the debt service-to-income ratio of households with debt payments is of more interest in terms of financial vulnerability; here, we observe the highest value in Croatia, where the share of households that use more than 40% of their income for debt service is 17.7%. Row 6 shows the share of indebted households that simultaneously surpass the vulnerability thresholds for the debt-to-assets (DTA) ratio, the debt-to-income (DTI) ratio and the debt service-to-income (DSTI) ratio. This number aims at taking into account all time horizons (short, medium and long term). The ratios are correlated by definition and play a part in banks' risk assessment. A bank might grant credit to a household with a relatively high value for one of these ratios, for example, a high DTA ratio, if the other two ratios, in this case the DTI and the DSTI, are relatively low (Albacete et.al., 2018). In Austria, only 0.3% of indebted households exceed all three ratios, which is the second-lowest share after Estonia. For other CESEE countries, the shares range from 0.4% in Poland to 2% in Hungary.

Another way of identifying potentially financially vulnerable households is to use subjective measures. In the HFCS, respondents are asked "Within the last 12 months, were your expenditures higher, lower, or about the same as your income?". If they state that their expenditures exceeded their income, they are asked how they covered this difference, either by using savings, selling assets, getting into new debt, getting help from friends, using a credit card or not paying their bills. Multiple responses are allowed. However, we assume that if a vulnerable

household[4] states that they do not pay their bills after considering all other options, it is very close to default. Table 5 (7th row) shows the share of indebted households that stated that their expenses surpassed their income in the last 12 months. The values range from 11.3% in Estonia and Slovenia to 28.8% in Croatia. In Austria, this share is 17.6%. The share of households that additionally stated that they did not pay their bills is 1.3%. This is the second-lowest value among the selected countries after Estonia. The highest shares are observed in Hungary and Croatia.

Chart 3 depicts the shares of vulnerable[5] indebted households' answers to the question how they covered their excess expenses. We observe the highest share of indebted households that did not pay their bills in Hungary, followed by Latvia and Lithuania. Furthermore, we observe differences between countries with regard to how households react to financial shortages. In Poland, for instance, getting into new debt is more common than in other countries, whereas in Croatia, credit cards are a common tool for financing. Selling assets is an uncommon reaction to shortages, households prefer to ask friends for help or to use savings; the latter is especially true for Austria and Slovakia.

Whether there are risks to financial stability stemming from potentially financially vulnerable households depends on how much debt these vulnerable households have and how much of each vulnerable household's debt is not covered by their assets. Loss given default (LGD) is a common measure that takes these considerations into account (see references at the beginning of section 3). We define it as:

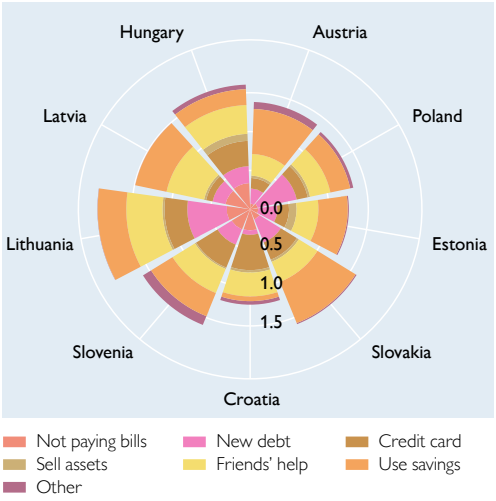
$$LGD = \frac{\sum_{i=1}^{N} PD_i \times (D_i - A_i) \times NW_i}{\sum_{i=1}^{N} D_i} \times 100,$$

where NW_i is an indicator variable, which is 1 if the household has negative net wealth ($D_i - A_i > 0$). PD_i indicates the probability of default for a household with negative net wealth. For non-subjective LGDs, this indicator is 1 if the debt service-to-income-ratio is greater than 0.4. For subjective LGDs, on the other hand, it is 1 if the household states they did not pay bills in order to finance financial shortages in the last 12 months. Table 6 shows the results for these two LGDs as well as the share of households with debt exceeding several kinds of assets with their respective share in total debt. It illustrates the path from all indebted households to those whose net wealth is negative and that are financially vulnerable. These

Chart 3

How indebted households cover financial shortages

Share of vulnerable[1] indebted households



Source: Eurosystem HFCS 2017.

[1] *"Vulnerable" according to the subjective "expenses above income" vulnerability measure.*

[4] *Expenditures above income.*

[5] *"Vulnerable" according to the subjective "expenses above income" vulnerability measure.*

households' debt, which is not backed by assets, is a potential loss for banks in the case of default.

In the first row of table 6, we see table 3's extensive margins on debt holding (column 1 for each country). These households hold 100% of total debt (column 2 for each country). After deducting deposits, there is a notable decrease, both in the share of households with debt exceeding deposits as well as their uncovered share in total debt. In Austria, for example, these 19.4% of total households hold 75.3% of total debt after deducting deposits. Both are the lowest shares among the countries under review. Deducting further financial assets as well as other real estate property does not reduce the shares notably. This is because these kinds of assets are held by a lower number of households (remember table 3). After subtracting the household main residence, however, there is another notable decrease to less than 8% in all countries in terms of being in debt and less than 13% in terms of the respective share of total debt that these households hold. This indicates that the household main residence is the main collateral for indebted households. In row 6 of table 6, there are the respective shares for households with negative net wealth, followed by nonsubjective LGDs. In all selected countries, the share of households with negative net wealth and a debt-to-income ratio above 0.4 is below 0.5%. The share of those households' uncovered debt in total debt (=LGD) is a crucial measure for the risk to the banking sector, and ranges from 0.03% in Estonia to 3.9% in Slovenia. In Austria, nonsubjective LGD is relatively low at 0.39%. Slovenia, Hungary and Lithuania are the countries with the highest nonsubjective LGDs, amounting to 3.9%, 2.9% and 2.1% of aggregate household debt, respectively. Changing the probability of default's defining characteristic to "not paying bills" from "having a debt-service-to-income ratio above 0.4" lowers the amount of potential losses in all countries. This is especially the case in Hungary (from 2.9% to 0.6%) and Slovenia (from 3.9% to 0.2%). The share of households

Table 6

Debt covered by different asset classes

	Austria		Estonia		Croatia		Hungary		Lithuania		Latvia		Poland		Slovenia		Slovakia	
	HH	Debt	HH	Debt	HH	Debt	HH	Debt	HH	Debt	HH	Debt	HH	Debt	HH	Debt	HH	Debt
	%																	
Debt	32.7	100.0	48.0	100.0	40.7	100.0	31.6	100.0	26.1	100.0	39.6	100.0	40.5	100.0	32.2	100.0	36.6	100.0
minus deposits	19.4	75.3	35.8	86.2	32.7	90.3	25.1	82.2	20.7	93.3	33.7	91.1	24.8	81.1	25.9	88.1	29.6	87.5
minus financial assets	17.8	68.3	32.8	77.3	30.5	85.2	23.7	76.8	19.1	84.6	31.9	86.6	22.1	75.7	22.9	81.3	27.5	82.1
minus financial assets and other real estate	16.1	57.1	25.2	48.5	25.7	73.5	20.0	61.5	15.3	61.4	23.0	55.2	17.7	55.6	17.6	58.3	23.5	66.7
minus financial assets, other real estate and household main residence	5.8	7.5	5.9	2.3	5.0	9.4	3.9	7.0	2.2	7.1	7.4	5.1	3.4	2.9	4.6	12.5	2.8	3.1
minus gross wealth	3.9	6.0	4.5	1.9	3.5	4.3	3.0	5.7	1.7	5.6	5.4	3.6	2.6	2.0	2.8	8.2	2.4	2.3
minus gross wealth & DSTI ratio ≥ 0.4 (LGD)	0.1	0.4	0.1	0.0	0.2	0.4	0.5	2.9	0.3	2.1	0.4	1.3	0.2	0.5	0.2	3.9	0.1	0.3
minus gross wealth & bills not paid (subjective LGD)	0.2	0.1	0.1	0.0	0.4	0.1	0.3	0.6	0.3	0.3	0.0	0.0	0.1	0.0	0.1	0.2	0.4	0.2

Source: Eurosystem HFCS 2017.

Note: This table shows the percentage share of households holding positive debt after deducting certain assets (HH) as well as the uncollateralized share of this debt in total debt (debt).

which are classified as potentially defaulting, on the other hand, may increase (e.g. in Austria from 0.1% to 0.2%) or decrease (e.g. in Poland from 0.2% to 0.1%) if we change the definition.

4 Comparing apples with apples: decomposition of differences

In this section we apply a machine learning approach to decompose differences of vulnerability measures between Austria and the selected CESEE countries into two groups – one group in which the differences can be explained with a number of observed household characteristics and a remainder – in order to answer the basic question of how much of the observed differences might be just due to different household compositions across countries. Household composition differs across countries for many reasons. Some differences also might have to do with the indebtedness or potential indebtedness of households and might therefore be endogenous in the sense that the availability of collateralized and uncollateralized loans might actually shape household composition itself. If loan-to-value ratio policies of banks or regulators differ across countries, households in some countries may be able to form new households by buying homes sooner than households in countries with stricter standards. Likewise, rent control and other housing policies might affect household formation and therefore household composition. However, we do not analyze the endogeneity of household formation and composition in this paper; we are merely interested in filtering out differences between financial vulnerability measures between countries which are attributable to differences in household composition. In other words, we want to compare apples with apples and see how much of the observed differences remain differences between similar households across countries. These remaining differences are those which actually stem from the different behavior of similar households or from the different behavior of banks toward similar households across different countries. Note that we use Austria as a benchmark. That means we reweight all other countries in a way that their household composition fits the Austrian household composition, so that we can compare the differences observed in Austria which are not due to differences in household composition. Results would likely differ if we used another country as a benchmark.

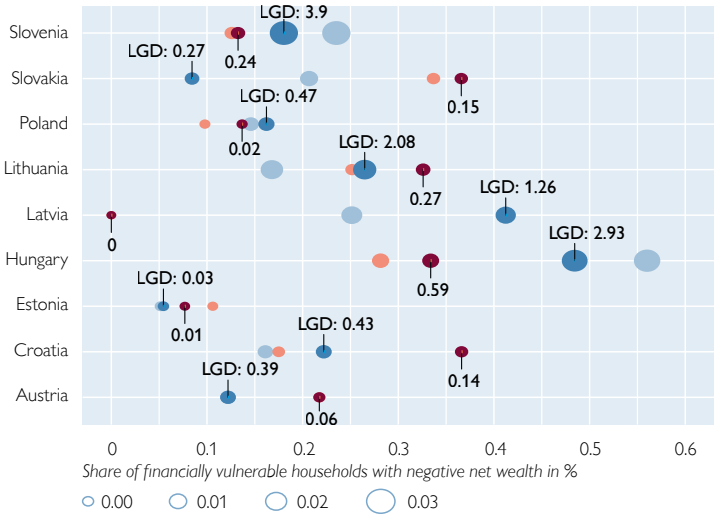
To reweight the data we use a reweighting method which is based on a gradient boosted model with a bernoulli loss function.[6] We perform 10, 50, 100, 500 and 1,000 iterations of an equation consisting of a dependent dummy variable, which is 1 if the observation was an Austrian household and 0 if it belongs to one other country. Based on this model (modeling the probability being an Austrian household given household characteristics), the weights are recalculated for all households in the country we want to compare to Austria. The reweighting procedure needs to be done separately for each country. The independent variables are the household heads' age, education, employment status and gender as well as the number of household members, which we consider of particular relevance to the lending process.

Chart 4 shows the results before and after reweighting. On the x-axis, there is the share of indebted households that are financially vulnerable and have negative net wealth. The dark blue dots and their respective sizes show LGDs for selected

[6] *All calculations are done using R's gbm package. See the annex for more methodological details.*

Chart 4

LGD and subjective LGD before and after reweighting



Source: Eurosystem HFCS 2017.

Note: All figures are percentages. Blue is nonsubjective (dark before reweighting, light after reweighting), red is subjective (dark before reweighting, light after reweighting).

countries, the dark red dots and their respective sizes show subjective LGDs for selected countries (see table 6 as well). The light blue dots and the light red dots and their respective sizes show the results for (subjective) LGDs after reweighting. We see that dot sizes, i.e. LGD, do not differ substantially after reweighting. On the other hand, the share of financially vulnerable households with negative net wealth might change. Both directions are possible, as we see that in Latvia the share of financially vulnerable households with negative net wealth decreases from over 0.41% to 0.25% after reweighting in the standard LGD definition. On the other hand, this share increases from 0.48% to over 0.55% in Hungary. For subjective LGDs, the share of financially vulnerable households with negative net wealth increases after reweighting in Estonia only. In all other countries, the reweighted shares are below the shares before reweighting.

5 Summary and conclusions

In this paper we employ recently available data of the third wave of the HFCS and focus on indebtedness and financial vulnerability in Austria compared to eight CESEE countries, namely Estonia, Croatia, Hungary, Lithuania, Latvia, Poland, Slovakia and Slovenia. For Croatia and Lithuania, this is the first available HFCS wave that allows such an analysis. The extensive and intensive margins of all measures considered revealed that homeownership is markedly higher in the CESEE countries than in Austria, but the value of real estate property is significantly lower. Given these low values of real estate property and the relatively high levels of debt, loan-to-value ratios above 40% are more frequent in the CESEE countries than in Austria.

Our analysis focuses on both subjective vulnerability measures, such as households' self-assessment, and nonsubjective measures, i.e. debt-to-assets (DTA), debt-to-income (DTI), debt service-to-income (DSTI) and loan-to-value (LTV) ratios, and the identification of those households that exceed certain vulnerability thresholds. The DSTI>40% vulnerability measure points toward households in Croatia, Lithuania, Slovenia and Hungary being particularly vulnerable. Slovenia, Hungary and Lithuania also have the highest loss given default, which is crucial to the Austrian banking sector.

Furthermore, we employ a procedure that decomposes the differences in the level of household financial vulnerability into two groups: differences that are due to household characteristics on the one hand and differences that result from other external factors on the other. In the first group, we find that a household head's

education was the main driver of the differences in household vulnerability when comparing Austrian households to CESEE households, followed by the number of household members, the household head's age, employment status and gender. What is most interesting is that the direction of the effects stemming from differences in household characteristics varies across countries: When we look at the share of financially vulnerable households (DSTI> 40%) with negative net wealth, differences in household composition increase overall vulnerability in Slovenia, Slovakia and Hungary and decrease overall vulnerability in the rest of the countries under review. The different directions of the effects indicate that there is no typical household structure that suggests a high level of vulnerability as different types of households are vulnerable across countries. When we consider debt coverage (loss given default), household structure has no significant effect.

The implications for the Austrian banking sector are as follows: We find that household debt in the CESEE countries in our sample is rather small compared to Austria. The financial position of households in Slovakia, Poland and Estonia seems to be quite good, whereas households in Croatia, Lithuania, Slovenia and Hungary are, financially, the most fragile according to the DSTI>40% vulnerability measure. For Austrian banks, the risk stemming from Croatian households would be small, while that stemming from Slovenian, Hungarian and Lithuanian households would be somewhat more pronounced.

In times like these it is extremely difficult to draw any conclusions, therefore we only want to point out this particularly important aspect: This time we should learn from this crisis and make sure that we have better data available to be prepared for the next one. Monitoring the indebtedness and risk-bearing capacities of households is extremely important in times of crisis. The fact that we still have to rely on survey data alone to analyze households' risk-bearing capacities should motivate policymakers to change this situation.

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Annex

In this section, we describe our calibrations for R's gbm package and our interpretation of the results.

For shrinkage, also called the learning rate, we chose 0.1, and the interaction depth, the maximum number of allowed interactions between independent variables, was set to 2. To consider overfitting, we compared the results for cross-validation and out-of-bag sample set (OOB). The number of folds we set was 2. Depending on the method, we found differences in how many trees were optimal. However, a household head's education was the main factor for reweighting when comparing

Table A1

Household weights summary statistics before and after reweighting

	Min	Q1	Median	Mean	Q3	Max
HFCS (CESEE)	10.48	287.06	645.77	1,056.49	1,383.86	12,362.04
50 trees (CESEE)	1.57	375.73	778.31	1,281.27	1,502.34	36,008.87
100 trees (CESEE)	0.98	344.57	739.12	1,306.18	1,483.90	72,531.68
500 trees (CESEE)	0.87	345.03	739.17	1,308.48	1,489.98	72,432.87
1000 trees (CESEE)	0.91	344.76	739.39	1,312.68	1,491.03	82,109.61

Source: Eurosystem HFCS 2017.

Table A2

Relative importance in the reweighting process for different interaction sets

Variable	Relative influence (%) for 10 trees	50 trees	100 trees	500 trees	1,000 trees
Education (household head)	46.61	40.95	39.07	33.97	33.14
Household size	44.85	35.34	31.49	25.39	24.83
Employment status (household head)	8.54	12.69	13.33	13.54	12.87
Age (household head)	0	4.31	9.04	17.66	20.32
Gender (household head)	0	6.71	7.07	9.44	8.84
Optimal number of trees (cross-validation)	10	50	close to but below 100	close to but below 500	close to but below 1,000
Optimal number of trees (out of bag sample set)	10	50	100	close or equal to 500	about 400-500

Source: Eurosystem HFCS 2017.

Austrian households to CESEE households in all five estimations, followed by the number of household members (see table A2). For the purpose of reweighting and the point we want to make when accounting for differences in household characteristics when comparing results between countries, we found that allowing for 100 trees was sufficient given the method's complexity compared to its usage. We want to show this in table A1.

The first row shows summary statistics for our HFCS sample's weights in Austria, the second row shows the same for the CESEE countries. When reweighting with 50 trees, there are notable changes for the CESEE countries, the same goes for 100. However, there are few to no differences in weights when increasing the number of trees to 500 or 1,000. We performed reweighting for each country's five implicates using Rubin's Rules (Little and Rubin, 2019).

Table A2 shows the estimations for the relative influence of independent variables for reweighting. The relative influence measures the importance of an explanatory variable by measuring the percentage reduction of the loss function (see Natekin and Knoll, 2013). One can see that a household head's education has the highest relative influence no matter what the number of trees is, followed by household size. Employment status and the household head's age are factors for reweighing if the number of trees increases. The latter rises to over 20% when the number of trees is set to 1,000. To find the optimal number of trees, we increased the number of trees step by step. When set to 10, cross-validation and OBB suggested that the maximum was optimal, the same goes for 50. This might be an indicator in favor of increasing the number of trees. When the number of tress was 100, cross-validation did not hit the maximum anymore, for neither 500 nor 1,000. OBB, however, suggested the optimal number of trees to be 400 to 500 when the number of tress was set to 1,000. Nevertheless, for the purpose of reweighting and the point we want to make when accounting for differences in household characteristics between countries, we found that allowing for 100 trees was sufficient.