WORKING MORE TO PAY THE MORTGAGE: HOUSEHOLD DEBT, INTEREST RATES AND LABOR SUPPLY

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Abstract

Exploiting the sizable changes of interest rates and Polish income tax data, I show that households work and earn more (less) when their floating-rate mortgage payments exogenously increase (decrease). For each additional 1 PLN of mortgage payment, households change their income by 0.35 PLN on average. The effect is significantly stronger for payment increases, consistent with the importance of consumption commitments. Furthermore, the labor supply response is more pronounced when labor adjustment costs are lower; and is accompanied by a drop in non-housing consumption. Implied elasticity of labor supply is significantly higher than existing estimates based on lottery winners.

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1 Introduction

There is extensive evidence that household borrowing significantly impacts the real economy and plays an important role in the transmission of monetary policy. Yet, existing evidence is almost exclusively focused on household consumption behavior (Iacoviello (2005); Calza, Monacelli and Stracca (2013); Garriga, Kydland and Šustek (2017); Jappelli and Scognamiglio (2018); Cloyne, Ferreira and Surico (2020)). In the basic mechanism, higher interest rates increase expenditures on debt repayment, and in turn reduce other consumption expenditures of indebted households (Di Maggio et al., 2017). The focus on consumption, however, ignores another important economic decision of households: labor supply.

Should we expect the size of debt payments to have a significant impact on labor supply of indebted households? According to theory, an increase in debt payments may induce households to increase their income by working more, especially in the presence of consumption commitments (Chetty and Szeidl, 2007).[1] However, the magnitude of this adjustment depends on how elastic household labor supply is, which is often described by *marginal propensity to earn* (MPE). The estimates of MPE in existing literature vary, but most studies based on lottery winnings find MPE of the order of 0.1 (Imbens, Rubin and Sacerdote, 2001; Cesarini et al., 2017; Picchio, Suetens and van Ours, 2018), which suggests that labor supply response to debt payments changes is likely to be small.

This paper shows that changes to the size of mortgage payments lead to a substantial labor supply response. When a monthly payment for preexisting mortgages increases (decreases) due to fluctuations in the reference rate of the loan (e.g. LIBOR), households respond by working and earning more (less). The magnitude of this effect is substantial: around 35% of the change in payment is translated into the change in income. Crucially, the effect is asymmetric: income response is significantly stronger for mortgage payment increases compared to decreases, consistent with the consumption commitment model.

I conduct the analysis in the context of the mortgage market in Poland, where 99.8% of mortgages are floating-rate loans.[2] For such loans, interests are determined by the sum of a reference rate (typically 3-Month WIBOR - *Warsaw Inter-bank Offered Rate*, analogous

[1] This is the implication in a simple theory model that abstracts from bankruptcy considerations. As shown by Bernstein (2019) and Donaldson, Piacentino and Thakor (2019), an increase in debt payments in the presence of bankruptcy considerations may also lead to a debt overhang effect and a reduction in household labor supply.

[2] Floating-rate loans are also dominant in other European countries, e.g. Spain or Ireland. They are similar to adjustable-rate mortgages but do not have a period during which the payment is fixed.

to LIBOR) and a fixed markup. Every 3-6 months the mortgage rate is updated to reflect the current level of the reference rate. The variation in payments driven by changes in the reference rate can be large: in my data, interest payments both increase and decrease by up to 50% in 2 years. In this setting, identifying households with preexisting mortgages, following them over time, and observing how their labor supply responds to changes in the mortgage payment provides a good opportunity to understand how the size of debt payments affects labor supply.

I analyze the evolution of mortgage payments and income between 2005 and 2015 using panel data of income tax declarations for the universe of Polish population. Using mortgage interests tax deduction, I identify a near-universe of mortgage holders with loans originated between 2002 and 2006, and I am able to follow the evolution of their mortgage payments and income between 2005 and 2015. To uncover the effect of debt payments on income, I exploit within-household variation in mortgage payments driven predominantly by changes in the reference rate of the loan. I confirm the strong link between the level of reference rate and the size of interest payments in my data using both graphical and regression analysis.

The main result of the paper is the positive effect of the size of mortgage payments on labor income, which I interpret as the effect on labor supply. The magnitude of the effect is substantial: On average, around 35% of the change in mortgage payment translates into change of the labor income. My basic specification regresses household income on the amount of the mortgage interest payment, controlling for individual fixed effects, and for fixed effects for the interaction of age, previous year income, and year, as well as the interaction of county and year. Because the amount of interests paid may also reflect factors other than the level of interest rates, such as prepayment or delinquency, I instrument interests paid with the level of reference rate and initial mortgage size, following other work that relies on shocks to interest rates for identification (Gupta, 2019). Conceptually, the specification compares how households with a large mortgage react to interest rates changes vis-a-vis those with a smaller or no mortgage.

My identification strategy relies on a similar logic as that behind shift-share instruments or difference in differences estimators. Household exposure to interest rates shocks, i.e., mortgage size, is endogenous and related to expectations about future income. Yet, as demonstrated by Borusyak, Hull and Jaravel (2018), the specification exploiting the interaction of endogenous exposure with a series of exogenous shocks can still successfuly recover the parameter of interest asymptotically. One could be concerned, however, that

with 11 years of data and two correlated reference rates as sources of shocks, my specification is still subject to concerns about the endogeneity of exposure.

The main concern is that households with larger mortgages are differentially sensitive to macroeconomic conditions for reasons other than the size of a mortgage payment, and hence observed relationship of debt and labor income may reflect an effect of an omitted variable. To alleviate this concern, I control for several other macroeconomic variables interacted with a quartile of mortgage size, and use local-area level variation in mortgage size, which is likely driven by differences in house prices, instead of household-specific exposure. In a further attempt to alleviate the omitted variable concern, and to enrich the analysis, I study the consumption response to higher mortgage payments. Using information on tax deductions for selected types of consumption and savings (charitable donations, private pension contributions, expenses on broadband internet), I show that consumption and savings decrease following an increase in the mortgage payment. The negative consumption response is consistent with existing literature and demonstrates the coexistence of consumption and labor supply adjustments. Importantly, it also alleviates the concern that the labor supply response reflects differential sensitivity of mortgage holders to macroeconomic conditions. If the income of mortgage holders merely happened to be higher when interest rates are higher, we would also expect their consumption to be higher, since income and consumption are usually positively correlated. Yet, the opposite is the case, consistent with mortgage holders adjusting to higher mortgage payments.

My final method of addressing the endogeneity concerns relies on comparing mortgage holders with loans denominated in different currencies and, thus, indexed with different reference rates. While mortgages denominated in Polish Zlotys (PLN) and indexed with WIBOR form the majority of my sample, a sizable number of mortgages is denominated in Swiss Francs (CHF) and indexed with LIBOR. Comparing households with mortgages of the same size, but subject to different interest rates shocks, may therefore be a useful way of isolating the effect of mortgage payments. In most years, however, the variation generated by this comparison is very limited because WIBOR and exchange rate-adjusted LIBOR are strongly correlated. Yet, that correlation substantially weakens between 2012-2014, when WIBOR continues to decline but LIBOR hits the zero lower bound and remains flat until it becomes negative in 2015. Comparing mortgage holders with PLN- and CHF-denominated loans over 2011-2015 reveals that the level of mortgage payment as of 2011 predicts a decline in the 2013-15 income of households with PLN-denominated mortgages but not for those with CHF-denominated mortgages. These results confirm the positive impact of

mortgage payment size on labor income using an alternative identifying variation..

The magnitude of the labor supply response that I document is large compared to existing literature on labor supply elasticity, but further analysis provides a helpful explanation for why that may be the case. I show that labor supply response following a payment increase is significantly stronger than reaction to a decrease. The asymmetry illustrates the importance of consumption commitments (Chetty and Szeidl, 2007): following a payment increase, households may find decreasing consumption too costly, which makes the labor supply response more pronounced. The asymmetry helps to reconcile my results with *marginal propensity to earn* estimates from the literature. Most existing studies of reactions to winning a lottery prize report MPE estimates that are significantly lower than my average MPE, but broadly in line with the estimate I obtain when focusing on reaction to payment decreases. My results show that extrapolating labor supply elasticities from contexts in which household budget constraint is relaxed may underestimate labor supply response in situations in which the budget constraint tightens. Higher MPE alleviates the difficulties that classic macroeconomic models have with accounting for low MPE and high MPC at the same time (Auclert, Bardóczy and Rognlie, 2020).

I complement the main findings by exploring the heterogeneity of the labor supply effect. According to theory, the effect should be higher when adjustment costs for labor supply are low, while adjustment costs for other consumption are high. Consistent with that, I document that the relative reaction of income from self-employment is significantly higher than the reaction of wages, which likely reflects greater ability of the self-employed to benefit from adjusting labor supply. Change in the pension income is not significant, which can be thought of as a placebo check for the validity of the specification. Labor supply response is also significantly stronger in areas with lower unemployment and for households with a high payment-to-income ratio, consistent with those households having relatively low costs of adjusting labor supply but high costs of adjusting non-housing consumption.

What mechanisms are responsible for the income response? I construct several proxies for additional labor market activities and show that they contribute to the observed effect. First, exploiting the fact that my data allows me to observe couples who file taxes jointly, I document a significant effect of spousal labor supply channel: households are more likely to be a dual-earner household when their mortgage payment is higher. Second, higher interests increase the probability that households receive a supplementary income from additional income-bearing gigs, on top of their regular employment. Third, house-

holds whose mortgage payments increase are more likely to change jobs, possibly taking a higher-paying job that they might have previously rejected because of negative compensating differentials. This set of mechanisms is not exhaustive. While I do not observe effort and hours worked, I expect that their increase also contributes to the observed income effect. Increased effort should be particularly important for households with more flexible sources of income, which is indirectly confirmed by strong response of self-employment profits.

My findings are consistent with the basic model of household optimization and hence are likely to generalize behind the analyzed setting.[3] Indeed, the positive link between the size of debt payments and labor supply is consistent with stylized facts from multiple contexts. Basic analysis of the US Survey of Consumer Finance shows that more indebted households work more hours per week; mortgage-holders in the Health and Retirement Study are less likely to be retired at any given age, and individuals with a mortgage in the Current Population Survey are less likely to report that they quit a job and are faster to find a new job when unemployed.[4] While all these relationships are only correlations, they are consistent with the results of my analysis and suggest that the positive impact of debt on labor supply can be generalized to other settings.

Several other papers also show evidence consistent with my findings. Fortin (1995) and Del Boca and Lusardi (2003) show that women are more likely to work when their household has a mortgage. Bednarzik, Kern and Hisnanick (2017) demonstrate that indebted individuals return to work faster after job displacement, while Brown and Matsa (2020) show that indebted households apply for more local jobs. A recent paper by Bernstein and Koudijs (2020) analyzes the impact of mortgage amortization schedule on wealth accumulation and confirms the positive impact of debt on labor supply, even though in their setting debt obligations merely shift in time and do not increase.[5] At the same time, the relationship between level of debt and household labor supply may be non-linear. Debt overhang effect may suppress labor supply for borrowers who are close to bankruptcy, have nega-

[3]The findings are also consistent with an intuitive idea that people work more when their obligations are higher, and hence can be interpreted as a household finance analogy of Jensen (1986) free cash flows result. Jensen's mechanism operates in corporate finance world through reduced agency problem, while the mechanism in this paper operates through the increase in effort, but both suggest that debt leads to higher income or profits.

[4]See Appendix Figures A.4, A.5 and A.6.

[5]Their estimates of labor supply response are of similar order of magnitude as mine, suggesting that the liquidity considerations are more important drivers of labor supply decisions than long-term wealth considerations. These findings are also consistent with low distortionary effect of delayed taxation documented by Fagereng and Ring (2021).

tive equity, and have non-recourse loans (Bernstein (2019) and Donaldson, Piacentino and Thakor (2019)). Higher labor supply may be also skewed towards better paid jobs: Rothstein and Rouse (2011) analyze student loans and show that higher debt leads students to choose higher-salary jobs, while Chakrabarti et al. (2020) show that student debt decreases probability of enrollment in graduate school.

Multiple papers analyze the link between debt, interest rates, consumption (Gross and Souleles, 2002; Agarwal et al., 2017; Kartashova and Zhou, 2020) and consumption-driven externalities (Verner and Gyöngyösi (2020)). Among them, Di Maggio et al. (2017) analyze the effect of mortgage payment declines due to ARM mortgages resets and show that they lead to increased consumption of cars and to voluntary deleveraging. Under several assumptions, their estimates suggest that around 80% of the decrease in payment may be spent on consumption. I complement their findings by showing that changes in the size of debt payments can also affect labor supply. In my setting, labor income changes by around 35% of the change in the mortgage payment. Documenting that interest rates can affect labor supply of mortgage holders contributes to the literature on the transmission of monetary policy (Bernanke and Gertler, 1995; Kashyap and Stein, 2000). The labor supply channel is novel and is likely to be quantitatively important especially in countries with high reliance on floating-rate or adjustable-rate mortgages. It counters the typical effects of monetary policy: when interest rates increase, the contractionary impulse transmitted through other channels is mitigated by the increase in labor supply.

My analysis can also be interpreted as studying the elasticity of labor supply with respect to consumption prices. If the consumption truly cannot be changed, and the price shock is expected to be permanent, this is similar to studying the elasticity of labor supply with respect to wealth or unearned income, although households may perceive these shocks differently. Imbens, Rubin and Sacerdote (2001) and Cesarini et al. (2017) show that 11-13% of an unearned income shock coming from lottery prizes is spent on reducing after-tax labor income. While these results are well-identified, as they rely on random events of winning a lottery prize, the very same methods applied in other contexts generate markedly different estimates. Picchio, Suetens and van Ours (2018) find MPE close to 0.02 using data from Netherlands, while recent work by Golosov et al. (2020) finds MPE as high as 0.5 in the US data. High estimates of labor supply elasticity are also obtained by Deshpande (2016) and Giupponi (2019), who show that 70-140% of lost disability/social security benefits is compensated with higher income. The high dispersion of labor supply elasticity estimates, despite all of these estimates being identified in convincing research

designs, underlines the importance of understanding the determinants of the heterogeneous labor supply response. My results offer one potential explanation: the asymmetric response to changes that relax or tighten the budget constraint. In doing so, my paper highlights potential challenges in extrapolating estimates based on lottery winners to larger parts of the population, and offers one potential explanation for why existing studies find a wide range of labor supply elasticities.

Finally, the paper contributes to the literature on the relationship between consumption and labor income. While it is generally recognized that the link between consumption and labor supply can go in both directions (Heckman, 1974), the existing literature focuses on analyzing how income shocks affect consumption adjustment (Jappelli and Pistaferri, 2010). I show the causal effect in the other direction: shocks to consumption prices[6] can affect labor supply and thus income. The income response is a mechanism through which households can smooth their consumption, contributing to widely documented "excess smoothness" (Blundell, Pistaferri and Saporta-Eksten, 2016). This effect is most relevant for categories of expenditures that are large and have high adjustment costs. While mortgage payment is a prime example of such category, many other expenditures can have these characteristics (e.g. child care, medical bills).

2 Mortgage and Labor Markets in Poland

Floating-Rate Mortgages Almost all mortgages in Poland – 99.8% as of 2016 – are floating-rate, which is the key feature that enables me to study the impact of changes in the size of mortgage payments over time. The fact that virtually all borrowers have floating-rate mortgage eases concerns about endogenous selection into fixed- or variable-rate mortgages. Strong dominance of variable-rate mortgages is not unique for Poland. The share of adjustable-rate mortgages is very high in several other countries, such as Austria and Portugal, but the opposite is true for countries such as Germany and Belgium. Albertazzi, Fringuellotti and Ongena (2020) discuss the drivers of those persistent differences in mortgage market institutions.

In a typical mortgage contract in Poland, the interest rate is defined as a reference rate, usually the 3-month *Warsaw Inter-bank Offer Rate* (WIBOR), plus a fixed markup. Dif-

[6] I simplify the exposition by referring to debt payments as consumption. While technically debt payments are not consumption, the debt-financed purchases are. We can therefore think about increases in mortgage payments as increases in the cost of housing.

ferently than for adjustable-rate mortgages in the United States or Great Britain, there is no initial period during which the rate is fixed. While the reference rate changes every day, each mortgage contract specifies the frequency with which the interest rate is updated, usually once every 3-6 months. In addition, some banks may not change the rate if the reference rate changed only slightly. In general, however, the variability in reference rate leads to changes in monthly mortgage payments, and the variation generated by these movements is fairly large in the analyzed period.

Other Mortgage Characteristics The typical length of a mortgage contract in Poland is 25-30 years, with the average being 26 years. Popularity of refinancing is limited because the main motivation to refinance, i.e., benefiting from a decrease in interest rates, is not relevant, as mortgage payments automatically incorporate changes in the overall level of interest rates. However, around 3-4% borrowers still refinance their mortgages, usually to benefit from the improvements in borrower's credit worthiness that allows for lowering the mark-up part of the interest rate. There is no exact data on the frequency of prepayments. Anecdotally, some borrowers do prepay their loans, but overall popularity of prepayment is limited by prepayment penalties, which before 2017 typically amounted to ~3% of the prepaid amount. As in most other European countries, home equity lines of credit are almost non-existent, and generally limited to firm owners.

All mortgages in Poland are recourse loans: the borrower still has to pay back the rest of the debt when the house is foreclosed and revenue from its sale is not enough to cover the total liability. Hence, there are no strategic bankruptcies, and while consumer bankruptcy is possible, it is rare in general. Around 2% of mortgages have delays in payments of more than 30 days, compared to 3.7% delinquent loans in the US. The Polish mortgage market is now regulated by guidelines of KNF (Komisja Nadzoru Finansowego, Financial Supervision Authority) that dictate the maximum level of payment to income ratio (currently 0.5), among other parameters. Before 2006, most of these recommendations were not yet in place, yet anecdotally banks maintained reasonably strict standards on their own, with payment-to-income ratio requirements of around 0.3-0.4. Unlike the United States, there are no signs of credit requirements in Poland being relaxed before the global financial crisis.

Some mortgages in Poland are denominated in foreign currency, typically Swiss Franc, and use LIBOR as their reference rate. I do not observe currency of the mortgage in my data, and the aggregate data on the popularity of foreign-currency loans for the time period of the analysis is not available, but share of loans denominated in foreign currency is likely

close to 25%.[7] I attempt to identify loan currency based on the evolution of interests paid over the life of the loan. In general, WIBOR- and LIBOR-based payments display a similar inverted-U pattern between 2005 and 2015. However, because LIBOR hit a zero bound at the end of 2012 and only became significantly negative in January 2015, the size of the interest payment based on LIBOR remained flat between 2012-2014. In contrast, interest payments linked to WIBOR significantly decreased between 2012-2014, providing an opportunity of using that period for identifying the currency of the loan in the data. I therefore classify a loan as denominated in Swiss Franc if the decrease in interests paid between 2012 and 2014 is smaller than 20%. Similar results are obtained using alternative classifications that also require the change in interests between 2007 and 2008 to be negative, and that are based on the distance between observed relative changes of interests for a given household and simulated differences for Zloty- and Franc-denominated loans.

Based on my data, I classify 26.2% loans as denominated in Swiss Francs. I employ three approaches to deal with these observations in the Instrumental Variable specifications. In the main approach, I use currency-specific reference rate, i.e., WIBOR for PLN-denominated loans and LIBOR for Franc-denominated loans. In the second approach, I drop CHF-denominated loans from the sample, focusing on loans denominated in Polish zloty. In the third approach, all mortgages are pooled together using WIBOR as a reference rate for all of them. This approach is warranted by the strong correlation between WIBOR and exchange-rate adjusted LIBOR (Appendix Figure A.3). For Zloty-denominated loans, variation in interests is the only source of non-deterministic variation in the monthly payment, while for Franc-denominated loans, additional variation comes from exchange-rate-driven fluctuations in capital part of the payment, which I do not directly observe. The link between the value of interests and total size of the payment is therefore weaker for Franc borrowers, which will bias the results from the sample including all mortgages towards zero.

To alleviate endogeneity concerns I also attempt to identify the income effect of mortgage payment size by comparing households with PLN- and CHF-denominated loans. Because the evolution of their mortgage payments differs mostly in 2013-2015, I attempt to estimate the differential income response in these years. I use sample covering 2011-2015 and explore how the level of interests paid in 2011 influences household income in years

[7] Between 2006 and 2009 average yearly share of new loans denominated in Swiss Francs varied between 22% and 66% (AMRON, 2009), but the upper bound represents 2008 which was an outlier. Between 2016-2020 Franc-denominated loans constituted around 25% of outstanding loans. Classification of loan currency based on the evolution of interests in my data suggests that 26.2% of loans are denominated in Swiss Franc.

2012-2015, depending on the currency of the loan.

History of Mortgage Market The time of origination of mortgages analyzed in this paper, 2002-2006, represents a relatively early phase in the development of Polish mortgage markets. While mortgage contracts have been issued to households since the beginning of the 1990s, right after the fall of communism, their popularity initially remained low. Historically, the alternative way of acquiring real estate was the membership in housing cooperatives, which remain important even today. Households interested in acquiring a property would become a member of a cooperative; the cooperative would then borrow money needed to complete the project, and the cooperative members will pay their dues over the years, effectively repaying the loan. In 1991, 96% of housing-related loans were issued to legal entities, including such cooperatives. Yet, legal changes introduced in 1997 paved a way for development of individual-oriented mortgage markets and the number and value of outstanding mortgages began to steadily grow (see Figure A.2). By 2002, when the mortgages analyzed in this paper were first issued, housing-related loans issued to legal entities constituted only 28% of total loans, while the remaining 72% were household mortgages.

Consistent with these developments, in 1997 the total value of outstanding mortgages was 2B zloty. It increased to 78B zl in 2006, and reached 374B zl in 2015. The growth in the value of outstanding mortgages is driven mostly by a generational change in the way of acquiring real estate: cohorts entering adulthood at the end 1990s and in 2000s were the first generation heavily relying on mortgages, and hence as they gradually started to purchase homes, the total number and outstanding balance of the loans began to rise. As documented in Appendix Figure A.2, the pace of this growth has recently slowed down, which is to some extent driven by the fact that the first borrowers reach the end of their loans and entering cohorts are off-set by those finishing loan repayment. That said, rising real estate prices and a modest increase in the size of residential units also contribute to the observed increase in the outstanding mortgage balance throughout the period.

Housing Market The housing market in Poland is split between single family houses and multiple-units apartment buildings. According to the last census, conducted in 2011, 40% of all units are single family houses. 56% of units are occupied by the owner, while 17% are rented. The remaining units are owned by cooperatives and occupied by their members, are public housing units, or are owned by employers and occupied by employees.[8] In 2015, 27% of owner-occupied units had an outstanding mortgage. Ownership

[8]It is worth noting that European Statistical Agency, Eurostat, reports ~84% home ownership rate for

without a mortgage is typically the case for units acquired before before 2000 and for units acquired through inheritance, which is relatively common. Housing prices in the period 2002-2006 were mostly flat. Prices increased significantly in years 2008-2009 and plateaued at the higher level afterwards (see Figure A.2 in the Appendix). Hence, the wealth of property owners who acquired their homes before 2006 increased between 2007-2015. However, their ability to capitalize on that increase without selling a house is limited given the absence of home equity lines of credit.

Labor Market Labor market institutions in Poland are similar to other European countries. The dominant type of contract is permanent employment, which usually features a 40-hour work week. The personal income tax rates have been 18% and 32% throughout most of the analyzed period on top of social security contributions. In total, employees typically take home around 70% of their gross salary and 60% of the total cost to the employer. Unemployment rate throughout most of the analyzed period was between 9.8% and 13.5%. Unemployment was higher in rural areas, where mortgages are significantly less popular, and hence unemployment rate faced by mortgage holders in my data was on average 2 percentage points lower. Importantly, in the entire analyzed period, the Polish economy witnessed economic growth and a relatively healthy labor market. Poland was the only member of European Union that did not experience a recession as an aftermath of the financial crisis. Due to a healthy financial system, no construction boom in the previous years, and a large demand for infrastructural investments, every quarter in the analyzed period had positive GDP growth. While unemployment hit lows in 2008 and increased slightly afterwards, the change was small (from 9.8% to 11-12%) compared to other European countries (e.g., in Spain unemployment went from around 10% to 20-25%). As a result in the entire analyzed period, both nominal and real incomes grew, as illustrated in Appendix Figure A.1 and in Table 1.

3 Data and Research Design

Dataset I use a panel dataset with 2005-2015 income tax declarations for the universe of Polish population. For each individual that filed a tax declaration in a given year, I observe their income from various sources (e.g., salary, pensions, self-employment); a set of characteristics such as sex, age or place of residence; and the value of claimed tax deductions. Filing the tax declaration is mandatory for anyone receiving any income other

Poland, effectively treating all non-renting as owning.

than social security income, and the process is standard. The data allows me to follow individuals over time and match married couples who are filing taxes jointly. The dataset was obtained from the Polish Ministry of Entrepreneurship and Technology; according to my knowledge, this is the first paper that uses the entire population of this dataset.[9] The data is confidential and has been anonymized so that it is impossible to identify any individual. Person identifiers are synthetic and monetary values are modified by adding a small random noise component to mask the exact values.

The data is based on the income tax declarations filled by individuals every year, usually in March or April of the following year. Employers send tax forms with income information, which I do not observe, to their employees and to the Tax Administration. Employees use the forms to fill tax declarations, which I observe, in which they include their total income, amount of taxes already withheld and deductions they would like to apply. These declarations are later sent to the Tax Administration, which processes returns and requests payments. Because the tax is normally withheld at the source, a typical taxpayer receives a modest return. Even though taxpayers declare their incomes themselves, the Tax Administration has employer records to validate the declarations and hence the measure of income is highly reliable. The amount of tax evasion in Poland, as proxied by the size of the shadow economy (see Medina and Schneider, 2017), is fairly similar to countries like Spain or Norway (share of the shadow economy in GDP of around 20%) and slightly larger compared to Germany or France (15%).

Mortgage Interests Tax Deduction Mortgage tax deduction is a key variable of interest that allows me to identify mortgage holders and observe their mortgage interest payments. The deduction was introduced in 2002 and abolished in 2007,[10] but households who started deducting interests during that period keep the right to deduct them until the end of their mortgage contract or until 2027. Therefore, if a household originated a mortgage and started deducting interests, e.g., in 2003, I am able to observe the amount they deduct throughout the whole period of my data, and thus I identify them as mortgage holders. However, if a household originated a mortgage in 2007, they are not allowed to use the deduction, and I do not identify them as mortgage holders in my data.

[9] Kopczuk (2012), who analyzes the effects of business tax reform on income and tax revenues, is another paper which uses micro data from the same source. However, he only analyzes a sub-sample of all taxpayers.

[10] The official reason for abolishing the deduction was related to the incompatibility of the law with the rules of European Union, which Poland joined in 2004. However, the fact that the law was abolished instead of being just slightly modified suggests that budgetary reasons were likely to also be a factor. Interestingly, the abolishment received little coverage and did not provoke a significant public discussion.

The group of mortgage holders that I analyze is, therefore, a near-universe of households who initiated a mortgage between 2002 and 2006.[11]. The remaining part of the universe of taxpayers is the control group. The number of mortgages originated before 2002 is very limited, and the majority of the control group are owners without mortgage. However, a non-negligible part of the control group are households with mortgages originating after 2006. My full-sample estimates, therefore, will be biased towards zero because part of the control group consists of households who also have mortgages and are subject to the treatment I analyze. In practice, however, this problem should not be very severe since mortgage holders form less than 15% of the control group based on the statistics on aggregate mortage markets in Amron-Sarfin reports. At the same time, focusing on the subset of mortgages originating between 2002 and 2006 is convenient because all the mortgages are preexisting at the time of large interest rate changes, which are the shocks that I exploit. I can, therefore, abstract from the problem of mortgage origination endogenously responding to the level of interest rate.

The deduction allows households to deduct all interests paid on their mortgage, irrespective of the level of the interest rate, if their initial mortgage size is below a threshold stipulated by the tax code. If the mortgage size is above the threshold, the household can deduct amount of interests paid multiplied by the ratio of the threshold to their mortgage size. The threshold varies over time, depending on the time of the first deduction, but the majority of mortgages do not exceed it.[12] My data contains only the amount of interests deducted and I cannot exactly determine whether a given mortgage exceeds the threshold. Based on auxiliary sources, however, I estimate that interests observed in the data correspond to around 90% of the true interests paid on average. The details of this estimate are discussed later when I take these differences into account when interpreting the magnitudes of the effects.

For the mortgage tax deduction, the amount of interest deducted is declared by the household based on the documentation received from the bank. While this documentation is not sent to the Tax Office with the tax declaration, it should be archived for at least 5 years for the purposes of potential tax audit. Only the amount of interests deducted is entered into the tax declaration.

Summary Statistics I limit the sample to individuals who are observed in the entire

[11] While households did not have to use the deduction, there was no incentive not to do so

[12] For exact definition, see Income Tax Act 26b.4.1-2. The most recent value of the threshold is 325,990 zloty.

analyzed period. My final data set is a strongly balanced panel with 9.8 million individuals and over 100 million observations. There are over 170 thousand of individuals identified as mortgage holders. Summary statistics for the main variables are presented in Table 1. Mortgage holders have two times higher income and are on average 6 years younger than the control group. Related to the age difference, they are less likely to receive pensions[13] and more likely to be self-employed. A typical household with a mortgage deducts almost 4.5 thousand zloty of interests per year. Not knowing the amount of principal paid every month, I am unable to compute the size of the total payment, but a reasonable estimate would imply that mortgage payments constitute around 10% of household income on average. This average is relatively low, partially due to the fact that while nominal and real incomes were constantly growing after 2006, interest rates were significantly lower in the second half of my sample.

Empirical Specification The empirical specification exploits within-household variation in the size of the mortgage payment driven by interest rate fluctuations to analyze the impact of the payment size on household's labor income and other outcomes:

$$Y_{i,t} = \alpha \cdot (Interests_{i,t} = RefRate_t \cdot Exposure_i) + \mu_i + \beta X_{i,t} + \varepsilon_{i,t} \tag{3.1}$$

The main explanatory variable, $Interests_{i,t}$, is the amount of interests paid by household i in year t. Interests constitute the majority of the entire mortgage payment in the initial years and capture entire non-deterministic variation in the payment for Zloty-denominated loans. In the basic specification, I directly include interests that I observe in the data. Their variation is driven mostly by fluctuations in the reference rate. To isolate only that part of variation and to disregard other more endogenous mechanisms such as prepayment, I instrument the size of interests paid with the level of reference rate, $RefRate_t$, multiplied by an estimate of the mortgage size, $Exposure_i$. In the main specification, reference rate is defined as WIBOR 3M for Zloty-denominated loans and LIBOR 3M for Franc-denominated loans, but Table A.4 in the Appendix explores alternative approaches. Mortgage size is measured by the second observed interest payment for a given household. Similar results are obtained when using average interest payment in the entire period instead; using first interest payment observed in the data is not appropriate because it often reflects interest payment for part of the year only.

[13] Pensions are reported in the data only when the household receives income from another source because the tax declaration is not required if a pension is the only source of income. As a result, the data excludes the majority of individuals aged 65 or above.

Table 1: Summary Statistics by Mortgage Status.

The sample contains all individuals who have tax records for the entire 2005-2015 period. Summary statistics are presented for observations included in the main regression sample, which requires non-missing data on age, previous income, and county of residence. Household-level variables are calculated as the sum of incomes/expenditures of two individuals who file taxes jointly in a given year. Number of observations in each row is the same and given in the last row of the table, except for rows which condition on positive value, where the number of observations is given next to the variable name. For internet expenses, the top 1% of outliers was winsorized because of unrealistically high values most likely reflecting data error. For interests, only positive values were included. For income growth, only changes between -100% and +100% were included.

	Mortgage = 0		Mortgage = 1	
Variable	Mean	SD	Mean	SD
Gross Household Income	54836	61619	107742	90972
%ΔHH Income	5.75	25.2	6.64	24.9
Wages	42253	54485	93768	88787
Business Profits	2781	30755	5251	21214
Pension	6909	15299	3446	12899
Share Self-Employed	10.0%	-	15.6%	-
Share Receiving Pension	25.8%	-	10.6%	-
Wages | >0 (N = 78.6M)	52946	56158	100893	88109
Business Profits !=0 (N = 9.9M)	27750	93526	33609	43899
Pension |>0 (N = 25.1M)	26738	19381	32656	24955
Interests Paid	-	-	4350	3828
Donations	36.1	1104	97	2494
Expenses - Private Pension	6.7	196	18.0	323
Expenses - Internet	139	260	224	319
Donations (| >0) (N = 2.9 ml)	1204	6264	2467	12317
Expenses - Private Pension (| >0) (N = 0.2 ml)	3301	2846	3991	2709
Expenses - Internet (| >0) (N = 25.1 ml)	575	172	608	206
Year Born	1965.1	12.5	1971.5	8.6
Number of Individuals (tho.)	9 648 152	-	171 445	-
Number of Observations	96 481 520	-	1 714 450	-

The basic specification controls for individual fixed effects, μ_i, and year fixed effects. In the preferred specification, the set of control variables, $X_{i,t}$, includes fixed effects for an interaction of age (in years), previous income (in 10 tho. zl bins), and year, as well as fixed effects for the interaction of county of residence and year. In further robustness checks, control variables include also other macroeconomic factors – unemployment rate, GDP growth, inflation – interacted with a quartile of mortgage size. The main outcome variable, $Y_{i,t}$, is a measure of household income, consumption, or other labor market outcomes.

The economic mechanism I analyze suggests that appropriate specification involves variables in levels, not logarithms: I expect an absolute increase in income to be proportional to an increase in interests, since households need to raise money to cover a given absolute level of the interest expenses. However, in robustness analysis I also include specification using logarithms and first differences of both dependent and independent variables. Income and interest payments are measured at a household level since couples file taxes jointly and they claim only one tax deduction. The sample contains individual-level observations and my main results are obtained with weights of 0.5 for 2-person household observations. Standard errors are clustered on the household level and in robustness checks by year.

Further specifications, presented in Tables 4 and 5, use a modification of the main specification from equation 3.1. The following specification that compares loans denominated in different currencies is estimated over 2011-2015 sample:

$$Y_{i,t} = \alpha \cdot (2011\,Interests_i \cdot \sum_{t=2012}^{2015} Year_t) + \beta \cdot 2011\,Interests_i \cdot Post\,2013_t \cdot PLN\,Loan_i + \mu_i + \beta X_{i,t} + \varepsilon_{i,t}. \tag{3.2}$$

The main coefficient of interest is β, which captures the differential income response of mortgage holder i with PLN-denominated loan (captured by the binary indicator $PLN\,Loan_i$) in years 2013-2015 (captured by binary indicator $Post\,2013_t$) to the level of interests payments of that household in 2011. In addition, I also estimate split-sample regressions with β set to zero for the set of mortgage holders with PLN-denominated loans and for the set of mortgage holders with CHF-denominated loans.

Table 5 estimates the assymetric effect of interest payment changes on income using following specification:

$$Y_{i,t} = \alpha \cdot Interests_{i,t} + \beta \cdot Interests_{i,t} \cdot Increase_{i,t} + \mu_i + \beta X_{i,t} + \varepsilon_{i,t}, \tag{3.3}$$

where $Increase_{i,t}$ is a binary indicator for payment increase, and the remaining variables are defined as in the main specification (equation 3.1). The indicator for increase is defined in three alternative ways, further discussed in section 4.3.

Endogeneity Discussion. The concerns about the endogeneity of interest payment changes can essentially be divided into concerns about the exogeneity of temporal variation in interests for a given level of exposure/mortgage size, and the concerns about the endogeneity of the exposure.

From the perspective of a household with mortgage of a given size, a change in the reference rate is an exogenous shock to the size of their mortgage payment. Yet, while most of the variation in interests paid is caused by the movements of reference rate, it is possible that some variation is related to household decisions or household-specific events. For example, when a household member loses their job, the bank may allow for suspending debt payments for a couple of months. Alternatively, when a household's economic situation improves, it may decide to refinance the mortgage and receive a lower rate thanks to better credit score.

To exclude these endogenous sources of variation, I use instrumental variable strategy, exploiting only the variation driven by changes in reference rate and fixed differences in exposure. Changes to WIBOR are closely related to changes of interest rates worldwide, consistent with strong correlation between WIBOR- and LIBOR-indexed payments documented in Appendix Figure A.3. As such, they are unlikely to be directly related to mortgage market conditions in Poland.

Undoubtedly, however, changes in the level of interest rates are related to overall economic conditions worldwide, which also affect the labor market situation in Poland. Therefore, the identifying assumption in the instrumental variable specification is that the influence of macroeconomic conditions captured by evolution of the reference rate, after controlling for age X previous year's income X year fixed effects, as well as county X year fixed effects, does not depend on the presence and size of the mortgage, except through the size of mortgage payment.

A potential violation of this assumption is the reason for the second source of the endogeneity concerns, i.e. concerns about the endogeneity of exposure. As demonstrated by Borusyak, Hull and Jaravel (2018), even when exposure to shocks is endogenous, a shift-share instrument specification that interacts the exposure with a number of exogenous shocks may recover the causal coefficient of interest. For that to be true, however, a large number of independent shocks is necessary, and shocks should be orthogonal to shock-level unobservables. In my setting, the number of shocks is modest: I analyze 11 years of interest rate changes, and exploit changes in two interest rates (WIBOR and LIBOR), which are highly correlated. In addition, one may be worried about shock-level unobservables that affect the outcome, such as wealth effects stemming from interest rates changes. For that reason, I include additional discussion of the setting and perform additional analysis that alleviates remaining endogeneity concerns.

The timeline of the events that I analyze makes it unlikely that household beliefs about

future income and decisions about mortgage origination generate a spurious correlation between income and the level of interests paid. For example, it is unlikely that household decided to take on a large mortgage in 2004 expecting that their income will be higher in 2008, but lower in 2010. A more realistic possibility is that households with large mortgages are unobservably different and this omitted variable is responsible for correlation of their income and interest rates. For example, they may be more likely to be white-collar rather than blue-collar workers and receive higher bonuses when interest rates are high, or their net wealth may be larger and shocks to interest rates affect them differentially also through the wealth channel.

Several elements of my analysis alleviate the concern about the violation of the identifying assumption. First, I analyze patterns of consumption response to an interest rate change and show that they move in the opposite direction as income. If the effects were due to differential sensitivity to macroeconomic conditions, we would expect that income and consumption go in the same direction. However, if the observed effect is a response to higher mortgage payments, we should expect income and other consumption to go in the opposite directions, which indeed is the case (Table 6). Second, I explicitly control for the interaction of macroeconomic variables – unemployment rate, inflation, GDP growth – and a quartile of mortgage size, which does not affect the main result (Table A.3). Third, I use local-level variation in the size of the mortgage, as opposed to individual-level exposure. Fourth, I argue that in a small open economy such as Poland, the relationship between level of interest rates and labor market conditions is unlikely to be strong and stable. Interest rates are strongly influenced by the international financial market situation, which is not necessarily related to the economic situation in Poland. For example, in the analyzed period the correlation between level of reference rate and unemployment rate in Poland was 0.13, while the correlation between LIBOR and unemployment rate in the entire European Union was -0.89.

Finally, the fifth element alleviating the endogeneity concerns relies on the comparison of loans denominated in Polish Zloty (PLN loans) and Swiss Francs (CHF loans). Conceptually, one would like to compare two households with mortgages of the same size, which are randomly assigned to loans originated in different currencies, hence, subject to different reference rates, and are subject to different changes in mortgage payments throughout the life of the loan. The ability to do so would alleviate many concerns about the comparability of households with smaller and larger mortgages and would provide a useful alternative to identify the income effects of debt payments size. In reality, that strategy has to deal with

two complications. First, evolution of payments for PLN and CHF loans is strongly correlated throughout most of the period (see appendix figure A.3) due to strong correlation between WIBOR and LIBOR, which means that the comparison of the two types of loans lacks identifying variation. To address that problem, in comparing PLN and CHF loans, I focus on years 2013-2015. Because LIBOR hit zero lower bound at the end of 2012, CHF loans saw generally stable payments afterwards. WIBOR, in contrast, continued to decline over 2013-2015, and so PLN loans payments continued to go down. The identifying variation generated by that difference provides a good opportunity to identify the income effect of debt payments, although a limitation of that approach is that the variation only comes from declines of mortgage payments (which, as detailed in section 4.3, likely have a different income effect than payment increases).

In addition, the currency of the loan is of course not randomly assigned. It remains true that unobservable household characteristics, such as level of risk aversion, might have influenced currency choice. On the one hand, taking on a mortgage in foreign currency may be associated with lower financial sophistication or lower risk aversion. However, households with CHF-denominated loans are generally wealthier and more likely to be urban than households with PLN-denominated loans. This is largely because not all banks were offering CHF-denominated loans, and anecdotally they might have been more popular among customers of banks concentrated in larger cities. Hence, the choice of currency may be to a large extent driven by quasi-exogenous factors, such as proximity to banks offering CHF loans or peer effects and, therefore, the comparison of households with loans of the same size, but in different currencies, is likely to be a good setting to identify the income effects.

4 Interest Payments and Labor Supply

4.1 Impact of Interest Rates on Mortgage Payments

I start the analysis by examining the link between the level of interest rates and the size of interest payments observed in the tax data. Because Equation 3.1, and thus all regressions in my analysis, includes individual fixed effects, the identifying variation comes from time variation in interests paid by a household. Conditional on paying any interests, this variation reflects mostly fluctuations in the reference rate, usually 3-month WIBOR or LIBOR.

Figure 1 shows that there is a strong relationship between average level of interests

in the data and the level of reference rate, defined as weighted average of WIBOR 3M and LIBOR CHF 3M, with weights of 0.74 and 0.26, respectively, corresponding to the shares of Zloty- and Franc-denominated loans in the data. The relationship is not perfect for several reasons: interest payments consists of reference rate and fixed markup, banks adjust contract rate with some delays or do not adjust them at all if the changes are too small, some mortgages may use different reference rates, etc. Nevertheless, the graph shows that the reference rate is an important driver of interest payments. Moreover, the magnitude of changes is large. Between 2006 and 2008 interests increased by around 50% and went down again by almost 50% between 2008 and 2010. Distributions of interest payments in 2008 and 2015 are shown in Figure 2, illustrating both the large changes in the interest payments across years, as well as substantial cross-sectional variation in exposure.

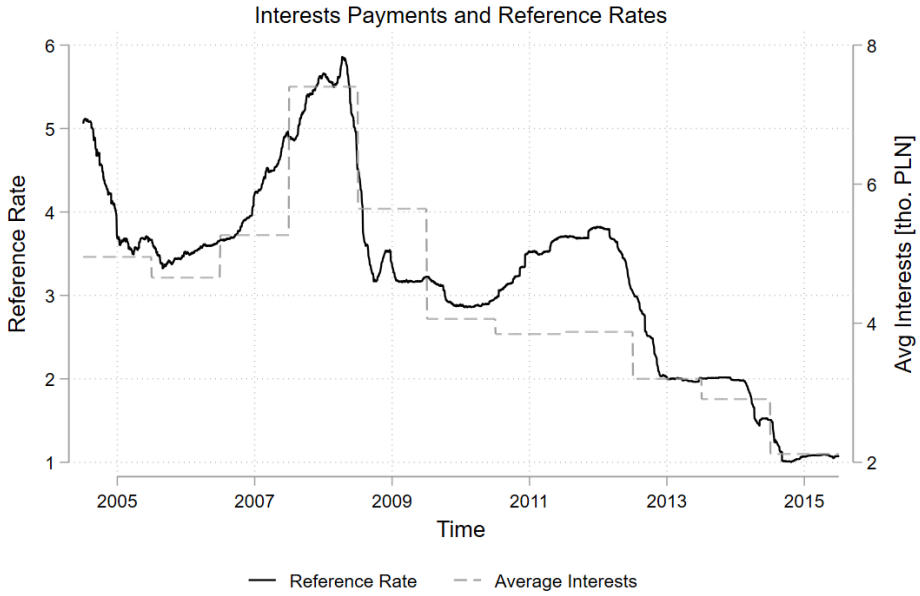

Figure 1: Average Interest Payments and Reference Rate.
The light-colored dashed line is the average value of interests deducted in a given year, conditioning on the deduction being positive for a given household. The dark-colored solid line is the synthetic reference rate: the level of the 3-month WIBOR (Warsaw Inter-bank Offer Rate) with 0.76 weight, and level of 3-month LIBOR with 0.26 weight, corresponding to shares of Zloty and Franc-denominated loans in the sample.

Table 2 confirms the relationship between interests paid and the reference rate using regression analysis. There is a highly significant relationship between reference rate interacted with mortgage size (approximated with the second interest payment of a household) and the amount of interest payments. This relationship is driven by both Zloty- and Franc-

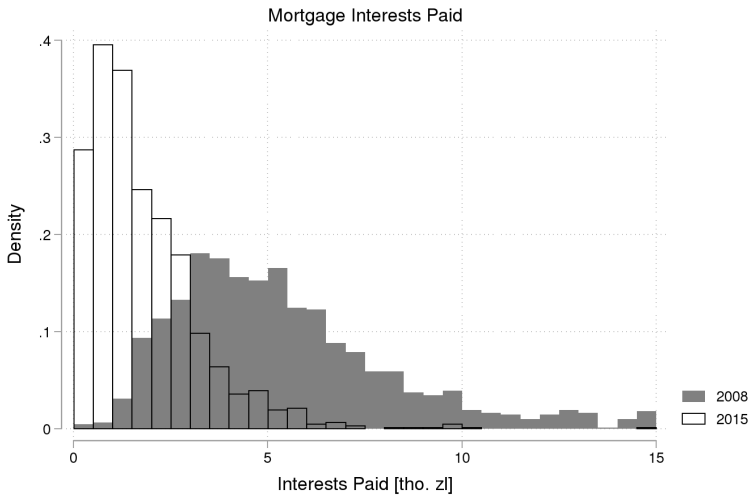

Figure 2: Distribution of Interests Paid in 2008 and 2015

The figure shows the distribution of interests paid in 2008 (gray bars, a year with the highest interest rates) and 2015 (white bars, a year with lowest interest rates). For graph readability, the value of interests is censored at 15 thousand zloty.

denominated mortgages, which load on WIBOR and LIBOR respectively, consistent with expectations.

4.2 Impact of Mortgage Payment on Labor Income

The main result of the paper is presented in Figure 3, and in Table 3, which show that an increase (decrease) in interests paid by the household is associated with higher (lower) income. Columns 1-4 and 6 include only mortgage holders and use intensive-margin variation in the size of the mortgage payment. Columns 5 and 7 use the full sample, including individuals without a mortgage.

The positive relationship is visible even when no controls beyond individual and year fixed effects are included (column 1), but the magnitude becomes larger once the regression controls for age and previous income (column 2, previous income included as a fixed effect for 10 thousand zloty bin, winsorized at 200 thousand zl). Further regressions include age-income-year fixed effects, as well as county-year fixed effects, although these steps have limited further impact on the estimated coefficients. The preferred specification suggests that 1 zloty increase in the size of the interest payment is associated with an increase in gross income of around 0.35 zloty, when relying on intensive margin variation in the size of mortgage only (column 4), and by around 0.3 zloty when relying on both intensive and

Table 2: Inter-Bank Interest Rates and Interest Payments

The dependent variable is the amount of interests deducted by a household in a given year. The main independent variable is the interaction of reference rate, which is a 3-month WIBOR or LIBOR CHF rate, with a proxy for mortgage size, which is the second amount of interests paid by a given household. All columns use strongly balanced panel with observations weighted by the inverse of the number of people in the household (1 or 2). Columns 1-2 include only mortgage holders, while columns 3-6 include all households. In columns 5 and 6, reference rate is split into WIBOR and LIBOR entering the regression separately, and the sample includes households with no mortgage and mortgages denominated in Polish Zloty only (column 5), or Swiss Franc only (column 6). All columns include individual fixed effects, previous income bin X age X year fixed effects, as well as county X year fixed effects. Standard errors are clustered at a household level in columns 1 and 3, and by year in columns 2, 4, 5, and 6. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Interests Paid					
	(1)	(2)	(3)	(4)	(5)	(6)
Reference Rate	0.223	0.223	0.223	0.223		
X Mortgage Size	(0.0005)	(0.012)	(0.0004)	(0.012)		
WIBOR X					0.144	-0.006
Mortgage Size					(0.053)	(0.035)
LIBOR X					0.002	0.234
Mortgage Size					(0.060)	(0.041)
N	1 714 450	1 714 450	98 195 970	98 195 970	97 746 780	96 930 710
Individual FE	✓	✓	✓	✓	✓	✓
Sample	Mortgage Only		Full		PLN Loans	CHF Loans
Clustering	Household	Year	Household		Year	

Table 3: Interest Payments and Income

The dependent variable is the total gross household income in Polish zlotys. The main independent variable is the amount of mortgage interests deducted from the taxable income. All columns use strongly balanced panel with observations weighted by the inverse of the number of people in the household (1 or 2). Columns 1-4 and 6 include only mortgage holders. Columns 5 and 7 include all households. Columns 6 and 7 present the specification from columns 4 and 5 in which interests variable is instrumented with the interaction of reference rate with the proxy for mortgage size. All columns include individual fixed effects, previous income bin X age X year fixed effects, as well as county X year fixed effects. Standard errors are clustered on the household level. F-stat presents Kleibergen-Paap Wald F statistic. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Gross Household Income						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interests	0.166	0.337	0.347	0.348	0.297	0.459	0.348
	(0.024)	(0.021)	(0.021)	(0.021)	(0.020)	(0.043)	(0.037)
N	1885895	1714450	1714450	1714450	98195970	1714450	98195970
Sample	Mortgage Holders				All	Mrtg	All
Ind, Year FE	✓	✓	✓	✓	✓	✓	✓
Prev Inc-Year FE		✓	✓	✓	✓	✓	✓
Pr Inc-Age-Year FE			✓	✓	✓	✓	✓
County-Year FE				✓	✓	✓	✓
IV						Reference Mortgage Size	Rate X
F-Stat						$5.5 \cdot 10^4$	$7.6 \cdot 10^4$

extensive margin variation (column 5).

In columns 6 and 7, the instrumental variable approach is implemented. Interests are instrumented with reference rate multiplied by the proxy for the size of exposure, i.e., the second interest payment of a given household. Both specifications produce positive and significant estimates of the impact of interest payments on labor income, which are slightly larger than the OLS estimates, although the confidence intervals are overlapping. The F-statistics from the first stage regressions are presented in the bottom row of the table, and are very large, consistent with the strong relationship of interests paid and reference rate documented in Table 2. When standard errors are clustered by year, rather than by household, F-statistics become smaller, but still greatly exceed any commonly used threshold for the strength of first stage relationship (Table A.2 in the Appendix).

Additional results related to the main specification are presented in the Appendix. The results are robust to different choices about the specification of the dependent and independent variables (logarithms or first differences instead of levels, Table A.1) and to different

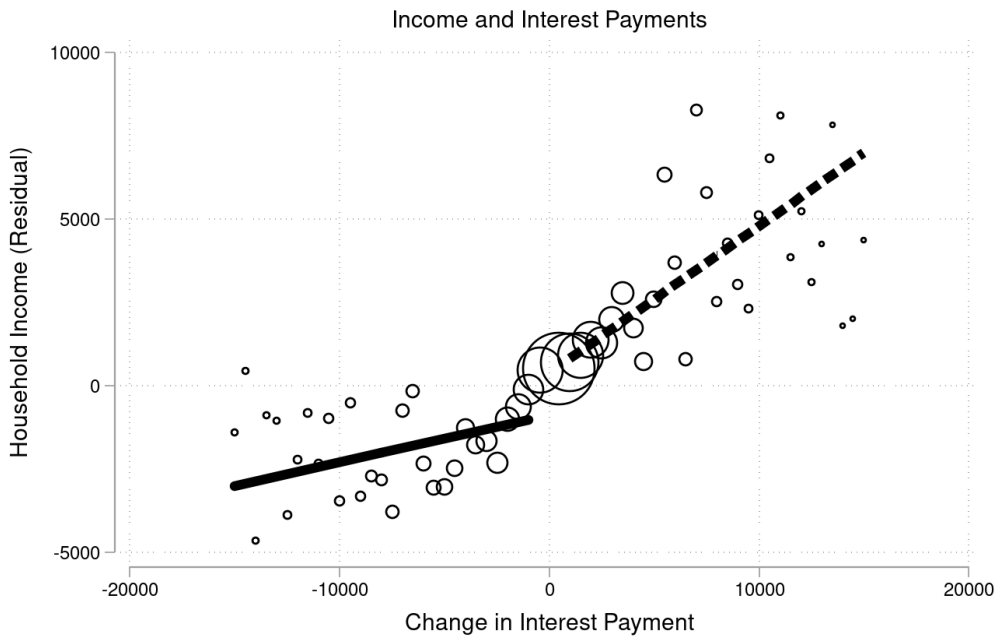

Figure 3: Income and Interest Payments

The graph is a bin-scatter plot of the residuals from a regression of household income on the fixed effects from the main speficiation (age-previous income-year and county-year), plotted against the change in the interest payment. The regression contains only mortgage holders and is similar to column 4 of Table 3 but with the independent variable being the change in the interests paid. Each dot corresponds to an average of residuals for all observations for which the value of the interest payment change, rounded to the nearest 500 PLN, is equal to the corresponding level on X-axis. The size of the dot is proportional to the number of observations in a given bin. The lines are linear trends based on a regression of the residuals on the change in the interest payments in a sample of positive and negative changes separately.

treatments of the reference rate in the IV specifications, depending on the currency denomination of the loan (Table A.4). They also remain strongly significant when standard errors are clustered by year, as opposed to clustering on a household level (Table A.2). Importantly, they change very little when interaction of the quartile of mortgage size (defined as zero for non-mortgage holders) with other macroeconomic variables – unemployment rate, GDP growth, inflation – are included in the regression (Table A.3), alleviating concerns that differential sensitivity to macroeconomic conditions is driving the results.

Further ways of addressing endogneneity concerns are presented in Table 4. Columns 1 and 2 show specifications with county-level variation in the size of exposure. Instead of using household-level mortgage size, I interact the reference rate with the average size of interests payments in a given county in 2007, analogous to measuring individual mortgage size with a second positive interest payment. The variation in the amount of interests paid

is likely correlated with house price differences across areas, but house prices cannot be directly used because the data is not available on the county level before 2015. Both columns 1 and 2 demonstrate that using local-area variation confirms the positive and significant response of labor supply to a change in interest payments. County-level clustered standard errors, however, become larger and the point estimates in intensive- and total-margin specifications are more dispersed, although they are still similar to those obtained in the main specification.

Columns 3-6 present results that compare households with loans denominated in Swiss Francs (CHF) and Polish Zlotys (PLN). As demonstrated in Appendix Figure A.3, payments for both types of loans change in a similar way throughout most of the analyzed period, because WIBOR and exchange-rate-adjusted LIBOR are strongly correlated. However, that correlation became weaker when LIBOR hit zero lower bound at the end of 2012 and remained near it until beginnings of 2015. In that period, CHF-denominated loans saw small changes in the monthly payment, but PLN-denominated loans continued to decline following the decline of WIBOR. As a result, comparing behavior of households with PLN- and CHF-denominated mortgages that had similar payments as of 2011 generates an opportunity to identify the effect of changing mortgage payments on income.

Columns 3-4 regress household income on interests paid by the household in 2011 interacted with fixed effects for years 2012-2015 and on an interaction of 2011 interests, indicator for PLN-denominated loan, and year greater or equal than 2013 (equation 3.3). That last coefficient captures the differential change in income in 2013-2015 for households that, as of 2011 had PLN-denominated loans with similar payment as the control group with CHF-denominated loans, but later on their payments became visibly lower because of continued decline of WIBOR (see appendix figure A.3). Consistent with the main result, the coefficient of that triple interaction is negative and significant in both columns 3 and 4, suggesting that lower mortgage payments led to a decline in household income, even compared to households with similar mortgage payments as of 2011.

A similar conclusion follows from split-sample regressions presented in columns 5-6 and on Figure 4. When regressing household income in years 2011-2015 on the level of interests paid by the household in 2011 interacted with yearly fixed effects, I estimate a decline in income for households with PLN-denominated loan but no significant changes for households with CHF-denominated loans. This is consistent with a sizable decline in PLN-denominated payments following a decline of WIBOR, and lack of large changes in CHF-denominated payments given that LIBOR was at the zero lower bound.

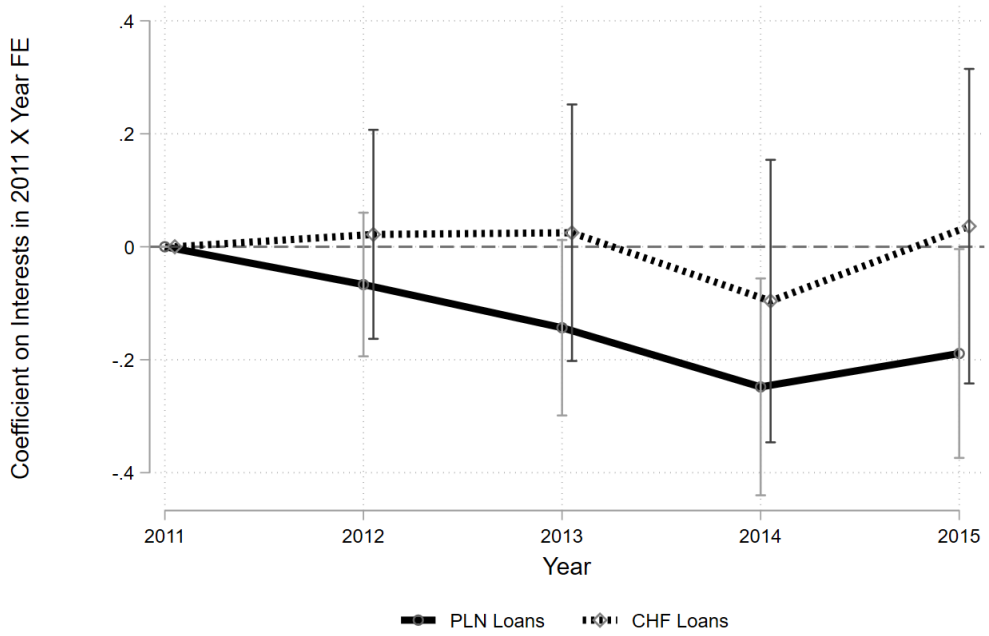

Figure 4: Income Effect of 2011 Interests by Loan Currency

The graph shows coefficients from household income regression presented in columns 5-6 of Table 4. The solid line shows coeficients on the level of interests paid in a given household in 2011 interacted with year fixed effects (for years 2012-2015) for households with mortgages denominated in Polish Zloty, while the dotted line shows analogous coefficients for households with mortgages denominated in Swiss Francs. Whiskers show 95% confidence intervals.

An important benefit of comparing loans denominated in different currencies is alleviating several concerns about the endogeneity of exposure. Even though the choice of currency is still rationally made by households, one can argue that the unobservable differences between housholds choosing PLN- and CHF-denominated loan are smaller than differences between households with smaller or larger mortgage. The limitation of the specification comparing PLN and CHF loans, however, is that it can only use a small part of the total variation in the size of mortgage payments. Because PLN- and CHF-denominated payments evolved in a similar way throughout most of the period, only the later part of the sample can provide enough variation to compare the two type of loans. In that part of the sample, interests rates were declining, and so the coefficient is only identified from the downward change in mortgage payments. Given that limited identifying variation, and in light of the assymetry of the effect discussed in the next section, I view the currency comparison results to be an important method of alleviating endongeneity concerns but consider estimates presented in Table 3 as the preferred specification.

Table 4: Labor Income Effect: Addressing Endogeneity Concerns

The dependent variable is the total gross household income. In columns 1-2, the main independent variable is the amount of mortgage interests deducted from the taxable income instrumented with the interaction of county-level average mortgage size and level of reference rate. In columns 3-6, the sample is limited to years 2011-2015. In columns 3-4, the main independent variable is the level of interests paid by a household in 2011 interacted with an indicator for year greater or equal to2013 and for loan being denominated in Polish Zlotys. The controls include level of interests from 2010 interacted with year fixed effects;hence, the main coefficient of interest captures the differential change in income for PLN-loans. Column 5-6 present split-sample regressions for sample of PLN- and CHF-denominated loans separately. Main independent variables are level of interest payments in 2010 interacted with year fixed effects. Standard errors are clustered on the county level in columns 1-2 and on household level in columns 3-6. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Gross Household Income					
	(1)	(2)	(3)	(4)	(5)	(6)
Interests	0.451	0.238				
	(0.055)	(0.092)				
Interests in 2011			-0.385	-0.309		
X Post-2013 X PLN Loan			(0.109)	(0.100)		
Interests in 2011 x 2012			-0.103	-0.074	-0.067	0.022
			(0.055)	(0.041)	(0.065)	(0.094)
Interests in 2011 x 2013			0.144	0.178	-0.143	0.025
			(0.010)	(0.097)	(0.079)	(0.116)
Interests in 2011 x 2014			0.033	0.120	-0.248	-0.096
			(0.105)	(0.098)	(0.098)	(0.128)
Interests in 2011 x 2015			0.078	0.083	-0.189	0.036
			(0.107)	(0.101)	(0.094)	(0.142)
N	1715133	98195970	1200091	68565716	865200	256712
Local-Area IV	✓	✓				
F-Stat	$1.9 \cdot 10^4$	$2.6 \cdot 10^4$				
Prev Inc X Age X Year FE	✓	✓	✓	✓	✓	✓
Sample	Mrtg	All	Mrtg	All	Mortgage	
				2011-2015		
					PLN	CHF

Interpretation of Magnitudes – Deduction Cap and Income Taxes To properly interpret the magnitudes, it is important to discuss the cap on the mortgage size, out of which interests can be deducted, as well as highlight that the analysis is performed for gross, as opposed to net, income. These factors have the opposite consequences for the relationship of the estimated coefficient to the true effect of debt on labor supply, and their joint effect is likely to be small.

Consider a household with mortgage size of 400 thousand zlotys and an applicable cap of 200 thousand zlotys. Suppose that the yearly interests for such household amount to 20 thousand zlotys. When these interests go up by 10%, the household pays two thousand zlotys more. However, in my data, I only see interests going up from 10 to 11 thousand zlotys, which will lead to overestimating the true effect of debt on labor supply. Unfortunately, the data is not rich enough to directly compute by how much the true effect is overestimated, but additional data sources allow me to perform the back-of-the-envelope calculations and estimate the importance of this channel. The applicable cap on the size of mortgage is approximately 191 thousand zlotys.[14] Based on Amron Sarfin Reports (AMRON, 2009), the average size of newly originated mortgages varied between 76 and 139 thousand zlotys between 2002 and 2006, with the volume-weighted average being equal to 107 thousand. I do not have more information about the distribution of mortgage size between 2002 and 2006, but I use the information for 2008 and 2009 to estimate the share of mortgages above 191 thousand and their average value.[15] This allows me to estimate that on average, the interests reported in my data represent around 90% of interests paid, hence, I divide the coefficients by ~1.11 to obtain better sense of economic magnitudes of the effect.

To understand the effect of debt on labor supply one also needs to take into account that the dependent variable in my analysis is the gross income. By construction, part of

[14] The cap varied between years and changed from 189 thousand zloty between 2002 and 2007 to over 326 thousand zloty in 2013 and later. To determine the size of the cap, the household first determines in which year their investment was completed (e.g., the house was built) and then uses the applicable value of the mortgage size limit. That is, even though the mortgage origination moment needs to be between 2002 and 2006 to use the deduction, the applicable limit depends not on the mortgage origination moment, but rather on the moment when the investment was completed. I assume that each investment is completed within 3 years of mortgage origination with uniform probability.

[15] For mortgages denominated in Polish zlotys, the growth in average mortgage size between 2006 and 2008 was around 60%. Hence, a mortgage size of 191 thousand in 2002-2006 would correspond to a mortgage size of 305 thousand in 2008. In the first quarter of 2008 almost 22% of all mortgages were above 300 thousand zlotys with the average mortgage size in this tail being 602 thousand. I am going to assume that between 2002-2006 there were 22% of mortgages above the cap with the average value of the mortgage being 383 thousand ($191 \cdot \frac{602}{300}$). This implies that the true value of interests paid for 22% of mortgage holders was higher than interests deducted and on average they have paid roughly 2 times more than they deducted.

the increase in payment is automatically countered by the increased tax deduction. Each 1 zloty of extra interests decreases taxable income by the tax rate, which is typically 18%. Thus, the net increase in mortgage expenditures is typically 0.82 zloty.

In the end, the cap on the mortgage size means that I overestimate the true effect on gross income, while the tax shield means that I underestimate the effect on the net income. Back of envelope calculations suggest that to recover the best estimate of the effect on labor supply, the original coefficients should be divided by 0.82 x 1.11. The results imply that labor supply increase covers 32.6-38.4% of the increase in the payment, based on the estimates from columns 4-5.

4.3 Asymmetry of the Effect

Estimates in Table 3 represent a reaction to both upward and downward changes of payments. It is possible, however, that the labor supply response is asymmetric. Indeed, consumption commitment model of Chetty and Szeidl (2007) suggests that the reaction to increases of payments may be larger than the reaction to decreases. Table 5 investigates this potential asymmetry in the response.

As illustrated in Figure 1, interest rates were increasing heavily in 2007 and 2008, and then decreasing in 2009-2011. Another smaller increase took place in 2011-2012, and the rates were further declining in the remaining part of the sample. However, with the annual data and possible delays in the incorporation of the updated level of interest rates in mortgage payments calculation, classification of interest rate increases and decreases is ambiguous. In addition, household response may be delayed and may depend on the size, duration, and intensity of the payment changes. I address these difficulties by using three approaches to the classification of increases and decreases in interest payments.

In columns 1-4 of Table 5, I use time series of interests paid by a given household. I define an increase of interests paid as a binary variable taking value 1 if the amount of interests in year t is higher than the amount of interests in year $t-1$ (columns 1-2), or higher than the average amount of interests in years $t-1$ and $t-2$ (columns 3-4).[16] The approach from columns 1-2 is also used to create the trend lines in Figure 3. These measures are most directly tied to the actual expenditures of a household but may be suffering from endogeneity concerns, as they may also reflect prepayment or debt forbearance. Thus, my second approach (columns 5-6) relies on the aggregate interest rates changes. Interest rates

[16] Similar results are obtained when I exclude small increases, e.g., smaller than 5% of the previous payment.

were going up in 2007-2008 and 2011-2012, and I define a binary indicator of increase in payment that takes value of 1 in these years.

Figure 3 and all columns in Table 5 show that the labor income response is significantly stronger when interest payments increase rather than decrease. The magnitude of the effect for payment increases varies between 2 to 3.5 times the size of the effect for decreases. These findings provide an important support for the theory of consumption commitments and help to explain why my estimates of labor supply response are larger than other estimates that rely on lottery prize winnings. Those other estimates rely on changes that relax household budget constraint, while my estimates show a substantial labor response to the tightening of budget constraint in particular. My estimates of reactions to interest rate decreases are more similar to other estimates in the literature, although some specifications (columns 4-6) still point to a significantly larger response.

Table 5: Asymmetry of the Labor Income Effect

The dependent variable is the total gross household income. The main independent variable is the amount of mortgage interests deducted from the taxable income and its interaction with the interests increase in a given year. The increase is defined as the interests paid by a household in a given year being higher than interests paid last year (columns 1-2), higher than the average of the last two years (columns 3-4), or the year being 2007-08 or 2011-12 (columns 5-6). All columns use strongly balanced panel with observations weighted by the inverse of the number of people in the household (1 or 2). Columns 1, 3, and 5 use only intensive-margin variation in the size of the mortgage, i.e., include only mortgage holders. Columns 2, 4 and 6 include all households. All columns include individual fixed effects, previous income bin X age X year fixed effects, as well as county X year fixed effects. Standard errors are clustered on the household level. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Gross Household Income					
	(1)	(2)	(3)	(4)	(5)	(6)
Interests	0.127	0.144	0.106	0.117	0.283	0.248
	(0.025)	(0.023)	(0.026)	(0.024)	(0.020)	(0.021)
Interests	0.253	0.235	0.279	0.313	0.277	0.233
X Increase	(0.104)	(0.101)	(0.091)	(0.088)	(0.014)	(0.015)
N	1714450	98195970	1714450	98195970	1714450	98195970
Increase Definition	HH Own Interests		HH Own Interests, 2Y		2007-08; 2011-12	
Ind, Year FE	✓	✓	✓	✓	✓	✓
Age X Prev. Inc FE & Trends	✓	✓	✓	✓	✓	✓
Sample	Mrtg	All	Mrtg	All	Mrtg	All

While lottery winnings provide an opportunity for a clean identification of the labor supply responses, my results illustrate that estimates based on them may be a poor proxy

for household reaction to other shocks that may be more prevalent. Interestingly, higher estimates of MPE resulting from my analysis help to alleviate the challenge that classical macroeconomic models have with reconciling low MPE, high MPC (marginal propensity to consume), and moderate level of fiscal multiplier (Auclert, Bardóczy and Rognlie, 2020).[17]

5 Consumption and Savings Response

A change in the size of the mortgage payment can lead not only to a change in income, but also to an adjustment of other, non-housing consumption. The main results of Section 4 confirm the importance of the income channel, but the magnitudes of the effect leave a lot of room for the consumption adjustment. Unfortunately, comprehensively measuring consumption in large data sets is difficult (e.g. Di Maggio et al. (2017) focus on selected categories of expenditures, such as cars), and such a measure is not available in the tax data. However, the data allows me to construct consumption measures based on tax deductions, which I analyze in this section. I employ specification analogous to Equation 3.1 with the dependent variable being a consumption or saving measure.

Three measures of consumption and savings are available in the data: charitable donations, contributions to private pension funds, and expenditures on internet access.[18] Deduction of internet access expenditures is very popular, but a household can use it only twice and has to do it in two consecutive years. For that reason, I limit my sample to households that used the deduction in the previous and current year, since for them the decrease in reported expenses indeed captures the reduced expenditures, as opposed to starting or stopping deducting them. Donations and contributions to private pension funds are less popular (Poland has a public pension system and private pensions are in infancy) but can be deducted each year. The results for all three proxies are presented in Table 6.

The results confirm the negative consumption and savings response. When interest payments are high, households reduce charitable donations, private pension contributions, and their expenditures on internet access. All the coefficients are relative to other households; consumption and savings may be increasing in absolute terms but at a slower pace. This is consistent with findings of Di Maggio et al. (2017) and suggests that analyzing the consumption response in more details with a more comprehensive measure of consumption is

[17] I thank Amir Kermani for bringing that macroeconomic puzzle to my attention.

[18] Some other deductions, such as a deduction for purchasing wheelchairs, are also available. These are extremely sparsely populated in the data and, hence, are not analyzed.

a promising avenue for future research.

The consumption and savings response supports the labor supply adjustment explanation for the main result in Table 3, as opposed to an alternative explanation based on differential sensitivity of mortgage holders to changes in interest rates. If we believe that the results are driven by unobservable characteristics of mortgage holders, which make their income more sensitive to interest rate changes, we should expect a positive response of consumption. Normally, when income increases, consumption also increases. Hence, if mortgage holders merely happen to earn more in years with higher interest rates, we should also see that they consume more. If households respond to the increase in the mortgage payment, we should see the opposite: households increase their income and decrease other consumption. The latter pattern is consistent with the data.

Table 6: Interest Payments and Consumption Proxies.

Dependent variable is log of 1 + charitable donations (columns 1-2), log of 1 + contributions to private pension account (IKZE, columns 3-4) and log of 1 + expenditures on internet access (columns 5-6). The sample in columns 5-6 is limited to households that used internet deduction in the previous year and have non-zero deduction in the current year (because of the 2 consecutive years limit for using the deduction). Main independent variable is the value of interests paid by the household in a given year expressed in thousands of zlotys. Columns 1, 3, 5 include only mortgage holders, while columns 2, 4, 6 include all households. All columns include individual fixed effects, previous income bin X age X year fixed effects, as well as county X year fixed effects. Standard errors are clustered on the household level. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Log(1+Donations)		Log(1+Expenses - Private Pensions)		Log(1+Expenses - Internet Access)	
	(1)	(2)	(3)	(4)	(5)	(6)
Interests/1000	-0.0010	-0.0018	-0.0004	-0.0006	-0.0019	-0.0018
	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
N	1 714 450	98 195 970	1 714 450	98 195 970	485 690	18 548 170
Sample	Mrtg	All	Mrtg	All	Mrtg	All
Pr Inc-Age-Year FE	✓	✓	✓	✓	✓	✓
County X Year FE	✓	✓	✓	✓	✓	✓

6 Heterogeneous Responses of Labor Supply

In this section, I analyze the heterogeneity of the labor supply response with respect to the type of income, local labor market conditions, and relative size of the mortgage.

Effects by the Type of Income Tax declarations require individuals to report their total income divided into different categories. While some of the income types are sparsely populated or rather obscure (e.g., other income), others can be used to gain additional insights about the observed effect and test its plausibility. In Table 7, I analyze the effect of mortgage interests on wages, pensions and income from self-employment.

Employment contracts may often be rigid: salary may not be directly related to effort and there may be no possibility for increasing the amount of hours worked (although, as demonstrated in Section 7, there are other ways in which employed persons can adjust their income). I expect that self-employed individuals have more opportunities to increase their labor supply and, therefore, the effect for business profits should be larger. Pensions, on the other hand, cannot be increased in the short term on the intensive margin and, hence, provide a useful placebo check.

Table 7 presents the estimates from the regressing logarithms of the three income types on the amount of interests paid. The effect for business profits is significantly higher than the effect for wages, consistent with the prediction that more flexible sources of income demonstrate stronger labor supply response. Nonetheless, we still see a positive and sizable response of the wage income. Coefficients for pensions are insignificant, consistent with the lack of ability to increase them in the short run.

Analyzing log-changes allows me to properly assess the strength of a relative response of given income type and eliminate potential confounding effects on the extensive margin. For example, while higher interests can encourage extra effort of self-employed individuals and increase business profits, they may also discourage households from taking the risk of starting a new business. Nonetheless, Appendix Table A.5 presents the analysis of the absolute level of different income types, confirming the significant responses of wages and self-employment profits but not pensions. Most of the income increase in absolute terms comes from wages because wages account for a great majority of the total income.

Heterogeneity with Respect to Unemployment Rate Increasing labor supply is a viable strategy to increase income only if the labor market provides appropriate employment opportunities. This is more likely to be the case in places with low unemployment rate, where it is easier to find an extra job or to increase the number of hours worked in the current job. Therefore, one may expect that the labor supply adjustment is more pronounced for households who live in areas with low unemployment.

To test this hypothesis, Panel A of Table 8 interacts interests paid with the local unemployment rate. Columns 1-2 reveal that the impact of higher interests is 0.013-0.025 lower

Table 7: Interest Payments and Income from Different Sources.

Dependent variable is the log of wages (columns 1-2), pensions (3-4) and business profits (5-6) on the household level. Main independent variable is the value of interests paid by the household in a given year expressed in thousands of Zloty. Columns 1, 3 and 5 include only mortgage holders, while columns 2, 4, 6 include all households. All columns include individual fixed effects, previous income bin X age X year fixed effects, county X year fixed effects, and fixed effects for the previous year value of the level of the dependent variable (wages rounded to the nearest 10 tho.; pensions and profits rounded to the nearest 5 tho.) Standard errors are clustered on the household level. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Log(Wages)		Log(Pensions)		Log(Profits)	
	(1)	(2)	(3)	(4)	(5)	(6)
Interests	0.0037	0.0029	-0.0001	0.0014	0.0107	0.0072
/1000	(0.0002)	(0.0002)	(0.0017)	(0.0017)	(0.0012)	(0.0012)
N	1 593 386	78 379 041	180 937	25 112 298	267 879	9 935 257
Sample	Mrtg	All	Mrtg	All	Mrtg	All
Prev Inc X Age X Year FE	✓	✓	✓	✓	✓	✓
County X Year FE	✓	✓	✓	✓	✓	✓

if county unemployment is 1 pp higher. With unemployment rates oscillating around 10%, this estimate is consistent with estimates in columns 3-4 that interact interests paid with a binary indicator for above-median level of local unemployment. Overall, the response of labor supply in places with high unemployment may be up to two times weaker than the response in places with low unemployment. Similar results are illustrated on Figure 5, which plots residuals from the regression of income on interest payment changes and two separate trend lines for observations with above- and below-median unemployment rate. These results confirm that the strength of labor supply response depends on the available labor market opportunities. In healthy labor markets, households can easily find additional job or increase hours in their current position, and increase their income in that way. If unemployment is high, however, opportunities to benefit from increasing labor supply are greatly limited.

Heterogeneity with Respect to Debt-to-Income Ratio Income response to mortgage payment changes need not be uniform in the whole population. In fact, one could expect that income adjustment should be more pronounced for households with a higher payment to income ratio. Such households are likely to have a higher share of necessities in their non-housing consumption; hence, it is more difficult for them to cover payment increase by reducing other consumption.

Panel B of Table 8 presents coefficients from the regression in which interests variable

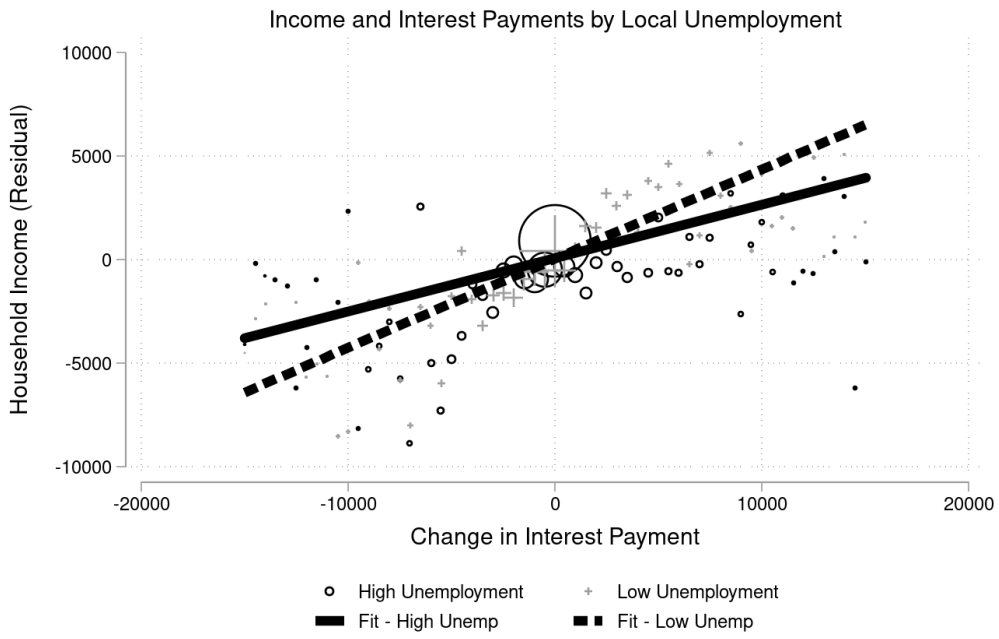

Figure 5: Income and Interest Payments by Unemployment Rate

The graph is a bin-scatter plot of the residuals from a regression of household income on the fixed effects from the main specification (i.e., age-previous income-year FE and county-year FE), plotted against the change in interest rates. The regression contains only mortgage holders and is similar to column 4 of Table 3 but with the independent variable being the change in interests paid. Each circle corresponds to an average of residuals for all observations for which the value of the interest payment change, rounded to the nearest 500 PLN, is equal to the corresponding level on X-axis, and for which unemployment rate in a county is above median. Plus markers are defined analogously but for observations with below-median unemployment. The size of each marker is proportional to the number of observations in a given bin. The lines are linear trends based on a regression of the residuals on the change in the interest payments for a sample of observations with above- and below-median unemployment rate (sold and dashed line, respectively).

is interacted with household's interests-to-income ratio or an indicator for this ratio being above median. The ratio is calculated using the amount of the second interest payment for a given household and their initial income level in year 2005. Similar results are obtained when using the average income and interests level over the whole sample. The results confirm that the labor supply response is stronger for households with a relatively larger mortgage. The magnitudes of the differences are again substantial: large mortgages lead to a labor supply response that is over two times stronger than the response of households with a below-median mortgage.

Table 8: Interest Payments and Income: Heterogeneity by Unemployment Rate and Mortgage Size

The dependent variable is the total gross household income in Polish zlotys. The main independent variable is the amount of mortgage interests deducted from the taxable income interacted with unemployment rate in the county of residence in a given year, an indicator for the unemployment rate being above median (Panel A), or with the initial ratio of interests to income for a given household, or an indicator for this ratio being above the median (Panel B). Columns 1, 3, 5, and 7 include only mortgage holders, while columns 2, 4, 6, and 8 include all households. All columns include individual fixed effects, previous income bin X age X year fixed effects, county X year fixed effects. Standard errors are clustered on county level in columns 1-4 (significant estimates are obtained also when clustering on the household level), and on the household level in columns 5-8. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Panel A: Unemployment Rate				Panel B: Mortgage Size			
	Gross Household Income				Gross Household Income			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interests	0.546	0.400	0.414	0.321	0.102	0.033	0.163	0.273
	(0.043)	(0.027)	(0.029)	(0.022)	(0.049)	(0.052)	(0.041)	(0.044)
Interests	-0.025	-0.013						
x Unemployment Rate	(0.004)	(0.003)						
Interests			-0.267	-0.107				
x High Unemployment			(0.041)	(0.031)				
Interests					2.021	2.383		
X Interest/Income Ratio					(0.403)	(0.425)		
Interests							0.191	0.140
X Large Mortgage							(0.40)	(0.045)
N	1714450	98195970	1714450	98195970	1714450	98195970	1714450	98195970
Sample	Mrtg	All	Mrtg	All	Mrtg	All	Mrtg	All
Prev Inc X Age X Year FE	✓	✓	✓	✓	✓	✓	✓	✓
County X Year FE	✓	✓	✓	✓	✓	✓	✓	✓

7 Mechanisms

What is the mechanism for the observed increase in income? Part of the effect is likely driven by an increase in hours worked in the current job. Unfortunately, the tax data does not have information on hours worked, but the fact that income from self-employment increases more than earnings does lend indirect support to this mechanism. Nonetheless, there are several alternative ways that a household can adjust labor supply, including spousal labor market entry, supplementary income, changing jobs, and working in multiple jobs. Not all of these channels can be directly observed; hence, I am unable to quantitatively asses their contribution to the income response. Instead, I provide qualitative evidence of their importance, which helps to understand the composition of the main effect. Some other channels, which I am not able to directly investigate, can also be playing a role. For example, an increase in interests can push individuals to take a tougher stance in bargaining with their employees and receive a wage increase.

Spousal Labor Supply If only one spouse in a household works, the household can increase its income by having the other spouse enter the employment. Existing literature (Fortin, 1995; Del Boca and Lusardi, 2003) shows that women are more likely to work if their household has a mortgage. In a similar way, one could expect that when mortgage payment increases, the non-working spouse, who usually is a woman in my data, enters the labor force. Yet, women labor participation in Poland is relatively high, and even higher in households with a mortgage, consistent with the literature. The margin for this adjustment can therefore be limited.

I investigate the spousal labor supply channel in columns 1-2 of Table 9. I limit the sample to couples who are filing jointly in the entire period, which allows me to disregard phenomena such as divorce. I define a single earner household as a household where only one of two persons declares positive income from wages or personal income. This is to exclude categories in which income may be arbitrarily assigned to both spouses, for example, income from financial assets, and may not reflect true labor force participation. The results suggest that spousal labor supply adjustment is a significant contributor to the observed income effect. A 1000 zloty increase in interest makes a household 0.1 pp less likely to be single earner household.

Supplementary Income Another possible way of increasing labor supply is performing additional, income-bearing gigs. An individual who works on a typical full time contract may decide to take extra after-hours jobs to supplement his main source of income. I am

able to partially identify such activity by analyzing the "personal activity" income category in the tax form. This category includes income obtained from activity performed personally but not subject to a formal employment contract (subject to labor regulations). An example of income that often will be reported in this category is a consulting fee that a professor, who receives a salary from a university, is paid by an outside firm. The indicator does not perfectly capture additional gigs. On the one hand, this category of income can also include standard employment income that is declared as subcontracting for tax purposes. On the other hand, an extra gig can also occasionally be reported as normal employment. Nonetheless, it is a useful proxy for capturing this type of labor supply adjustment.

I define supplemental income indicator as 1 when an individual receives salary income and declares non-zero personal activity income in a given year; and 0 otherwise. The results are presented in columns 3-4 of Table 9. The coefficient of interests is positive and significant and indicates that when interests are higher by 1000 zloty, the probability of receiving supplementary income is higher by 0.01 pp, or ~1% of the baseline rate. The result suggests that even individuals with rigid employment contracts may increase their income by performing income-bearing activities outside of their normal workplace.

New Job An employed individual can increase his income by changing jobs to a better-paid position, or working a second job. Why should we expect that an individual takes a better-paid job only when the mortgage payment increases, and not earlier? It is possible that jobs that pay more are worse in terms of non-monetary benefits: working conditions, required effort or location (Sorkin, 2017). An individual may be therefore hesitant to accept the better-paid position in normal times, but when extra money is badly needed, he can reconsider his choice and decide to take the job, sacrificing some non-pecuniary benefits for the sake of higher income.

I am using proxies for changing job and an indicator for working in multiple jobs based on the tax deduction available to every employee. Every worker with an employment contract can decrease its taxable income by an amount determined in the tax code. This amount is almost fixed and depends only on two factors: 1) whether an individual works in the same town in which he lives or not (higher deduction if one needs to commute to different town); 2) whether the individual works in a single job or in multiple jobs (higher deduction for multiple jobs). I define the "change job" variable as any change in the deduction amount. It needs to be noted that my measures captures both change of job and change of the place of residence. Yet, given the fact that I focus on mortgage holders, the second is less likely.

The results for the changing job measure are presented in columns 5-6 of Table 9.

When interest payments are high, workers are more likely to change jobs, consistent with changing preferences over pecuniary- and non-pecuniary benefits. While the coefficients of interests paid in the analysis of the probability of working on multiple contracts are positive, they are small and insignificant and these results are not reported to conserve space. The lack of significant response along multiple-jobs margin may be related to the fact that this arrangement is rarely observed in general, and is concentrated among lower-paid jobs that are unlikely to be held by mortgage holders.

Table 9: Mechanisms of the Increase in Income

The dependent variables are: indicators for a single-earner household (columns 1-2), indicators for getting supplementary income (columns 3-4, personal income on top of wages), and indicators for changing jobs (column 5-6). They are expressed in percentage points (i.e., the value of the dependent variable is 0 or 100). The main independent variable is the amount of mortgage interests deducted from the taxable income in thousand zlotys, for readability of coefficients. Columns 1, 3, and 5 include only mortgage holders, while columns 2, 4, and 6 include all households. Sample in columns 1-2 is limited to all married couples filling declarations jointly through the entire time period; sample in columns 5-6 is limited to individuals with employment contracts (for whom decreases in taxable income can be used to proxy for job change). All columns include individual fixed effects, previous income bin X age X year fixed effects, county X year fixed effects. Standard errors are clustered on the household level. Significance levels: *** - 0.01, ** - 0.05, * 0.1. Means of dependent variables are presented in the bottom row of the table.

	Single Earner (%)		Supplemental Income (%)		Change Job (%)	
	(1)	(2)	(3)	(4)	(5)	(6)
Interests / 1000	-0.113	-0.185	0.013	0.015	0.104	0.150
	(0.021)	(0.021)	(0.007)	(0.007)	(0.013)	(0.012)
N	761320	45649730	1714450	98195970	1476150	69031856
Sample	Mrtg	All	Mrtg	All	Mrtg	All
Pr Inc-Age-Year FE	✓	✓	✓	✓	✓	✓
County X Year FE	✓	✓	✓	✓	✓	✓
Mean Dep. Var	27.5 (%)	35.4 (%)	4.2 (%)	1.6 (%)	21.9 (%)	20.4 (%)

8 Conclusions

This paper presents the evidence that households change their labor income when their mortgage payment changes. The effect is quantitatively sizable, as around 35% of the change in payment translates into a change in income and might have important implications for understanding the relationship between consumer debt and labor markets, as well

as for monetary policy and debt relief policies.

The positive association between debt and labor supply is present in several other contexts. While causality is difficult to establish, separate analyses of Survey of Consumer Finance, Current Population Survey, and Health and Retirement Study all suggest that debt is associated with working harder. Figures A.4, A.5 and A.6 in the Appendix contain some graphical evidence from these analyses. Individuals with a mortgage work more hours per week, are less likely to quit their job, and are generally faster to find a new job when unemployed compared to those who do not have a mortgage. People with debt are also less likely to be retired at any given age. It is evident that the positive relationship between debt and labor supply is widespread and can have widespread implications.

At the same time, it should be noted that in the period of my analysis (2005-2015), the Polish economy was constantly growing and labor market conditions were relatively good, contrary to other countries in the same period. Because the labor supply response is stronger when unemployment is low, during a recession the change in income may be more modest. On the other hand, the labor supply response is also larger for households with higher payment-to-income ratios. Given that typical levels of PTI in my sample are relative low, the labor supply response in other contexts may be more pronounced. Labor supply may be also becoming more elastic as the popularity of gig-work and other flexbile employment opportunities increases.

There are several practical implications of my findings. First, they are of interest to those responsible for monetary policy. I establish that the contractionary effects of interest rate increase, which happen through several traditional channels, are accompanied by an increase in labor supply of mortgage holders. This effect is most sizable for countries with a high share of mortgages with floating or adjustable rates. Nonetheless, it may be manifested also for households with a fixed-rate mortgage through the refinancing channel.

Second, policymakers are often interested in helping households with a high debt burden. US Government's HAMP program is a recent example of such an action. My research shows that when designing such policies, it is worth taking into account household's potential to increase labor supply. Optimal policy would likely give higher benefits to households that cannot easily increase labor supply, e.g., because they are located in areas with high unemployment. It might also be optimal to introduce built-in incentives that encourage labor supply adjustment.

More generally, my results have implications for design of bankruptcy and recourse laws. Debt has important implications for labor supply and, therefore, personal bankruptcy

law can have important implications for labor markets. The more lenient the law on bankruptcy and recourse, the lower is the motivation for households to increase labor supply. On the one hand, this can be treated as moral hazard costs. On the other hand, if increasing labor supply leads to misallocation of resources (e.g., because highly-educated people are forced to accept jobs below their qualifications), more lenient laws can improve allocative efficiency.

My results also have implications for assessing credit worthiness of individuals. The potential to increase labor supply is likely to be an important predictor of whether a household is a good or bad borrower. While this potential is not directly observable, it can be proxied with education, sector, labor market situation in a local area, and current workload (i.e., persons with low current workload have more room for increasing labor supply).

Finally, my results have implications for any decisions that depend on the estimates of labor supply elasticities, e.g., taxation. While previous literature has suggested that labor supply responds relatively little to changes in unearned income or wealth, these estimates were based on changes that loosened household budget constraint. My estimates suggests that labor supply is significantly more responsive to changes that tighten the budget constraint.

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Online Appendix

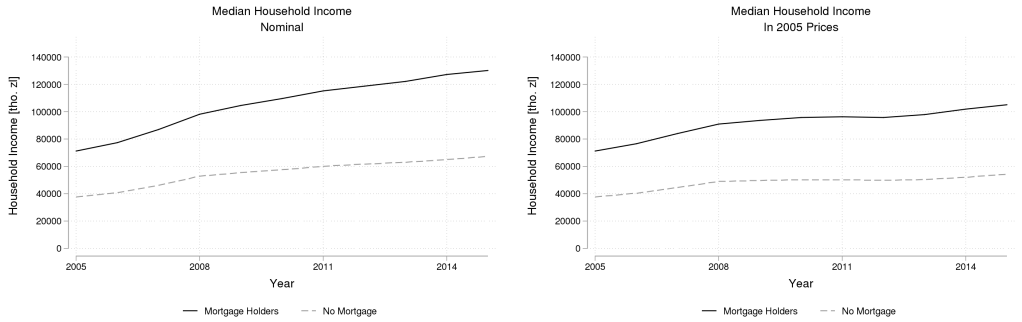

Figure A.1: Median Household Income By Mortgage Status

The figure shows the evolution of median household income by mortgage status. The left panel shows nominal income, while the right panel shows real income in 2005 prices (CPI used as the deflator).

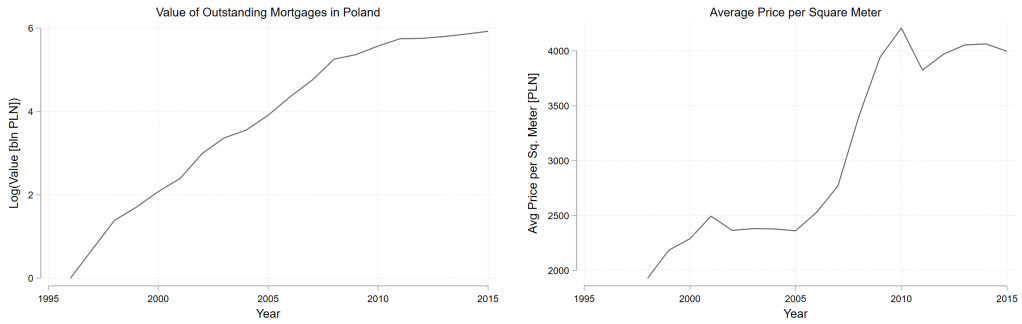

Figure A.2: Value of Outstanding Mortgages and House Prices

The left panel shows the natural logarithm of the value of all outstanding mortgages, based on GUS (Statistical Office) data. The right panel shows the evolution of house prices, also from GUS data, based on the average price per square meter at the end of the 2nd and the 4th quarter of a given year for newly sold housing units.

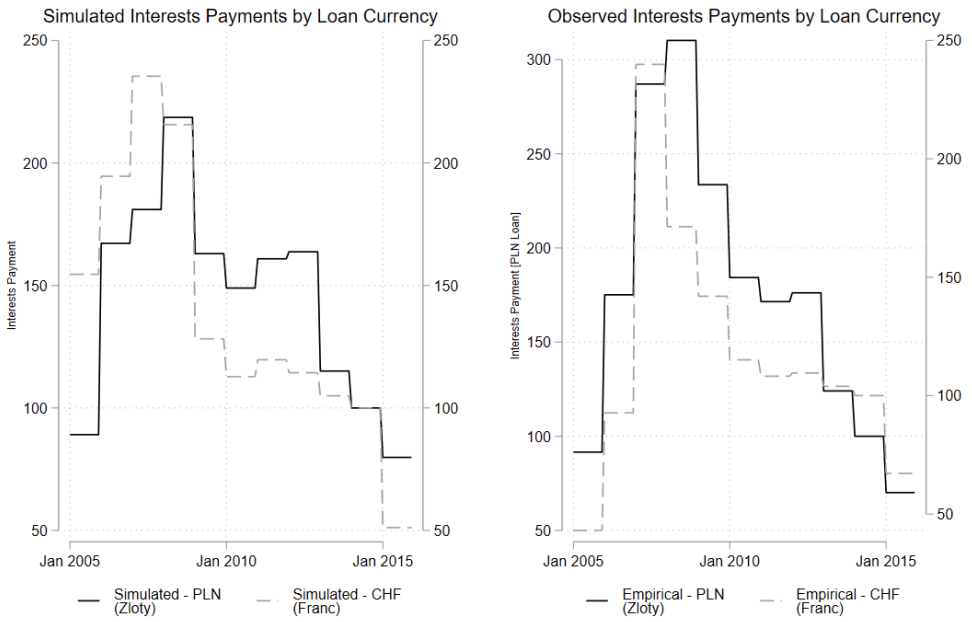

Figure A.3: Comparison of Zloty- and Franc-Denominated Loans

The left panel presents the evolution of an interest payment for a hypothetical loan with the first payment occurring in July 2005. Bank markup is assumed to be 1.5% for a CHF-denominated loan and 2% for a PLN-denominated loan, and the loan duration is assumed to be 30 years. To compute monetary values, the borrowed amount was set to CHF100,000/PLN260,230, but the interests series was further normalized so that the value in 2014 equals 100. Interest payments are calculated based on the values of WIBOR 3M, LIBOR CHF 3M, and CHFPLN exchange rate in a given month (closing values; retrieved from Stooq.com), and converted to PLN. The right panel presents the evolution of interest payment in the data, for loans classified as PLN- and CHF-denominated. Consistent with the simulation, loans classified as CHF-denominated exhibit flat interest pattern between 2011-2014, while loans classified as PLN-denominated exhibit a drop in interests paid between 2012 and 2013.

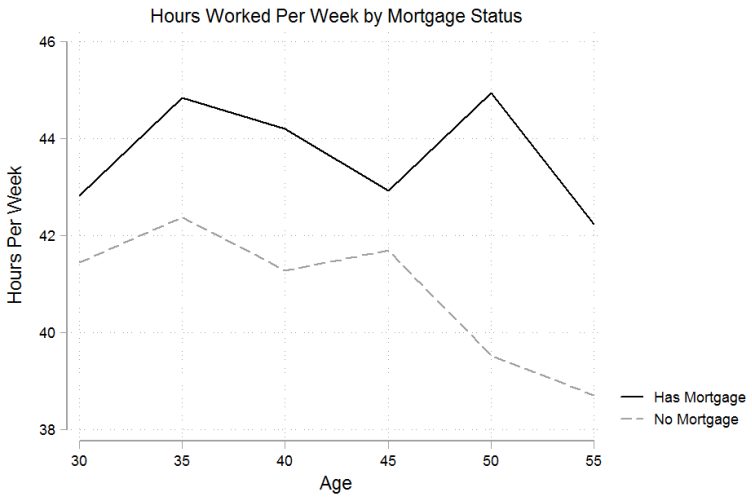

Figure A.4: Hours Worked by Age and Mortgage Status (SCF)

The data comes from Survey of Consumer Finance 2016 of United States Federal Reserve. Mortgage status is based on variable X723. Respondents with answers different than yes (1) and no (5) were dropped. Hours worked use variable X4110. Age, defined as the difference between 2016 and the year of birth, is rounded to the nearest multiple of five.

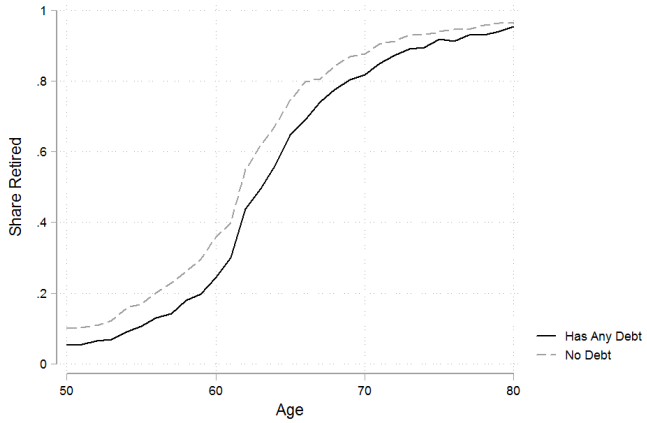

Figure A.5: Share of Retirees by Age for Mortgage Holders and Non-Holders (HRS)

The data comes from RAND 2014 Health and Retirement Study longitudinal file. The sample includes all respondents between 50 and 80 years old. "Retirement status" is a binary indicator based on respondent's declaration if he/she considers him/herself retired. If partly retired, the variable takes value 0.5. Respondents with answer "question irrelevant" were dropped. "Has any debt" is defined as total debt being above zero, where total debt is the sum of a mortgage, other home loans, other debt and 2nd home mortgage. Age is respondent age (agey_m variable) rounded to the nearest integer.

Figure A.6: Quitting and Unemployment Duration by Housing Status (CPS)

The data comes from IPUMS Current Population Survey (Sarah Flood, Miriam King, Renae Rodgers, Steven Ruggles, and J. Robert Warren. Integrated Public Use Microdata Series, Current Population Survey: Version 6.0 [dataset]. Minneapolis, MN: IPUMS, 2018. https://doi.org/10.18128/D030.V6.0). The sample contains observations from 2010-2017. Individuals are included in the sample if in any of these years their mortgage status is not missing (variable spmmort, which also defines the three groups presented on the graph). Quitting and firing is identified based on declared reason for being unemployed. Duration of unemployment is measured using variable durunemp. The bars show the share of respondents who are unemployed and declare that they lost their job and are not "other job loser" (excludes layoffs) among all those who are unemployed and have a given mortgage/tenure status. The line shows the average value of unemployment duration (in weeks) for respondents who are currently unemployed and were fired.

Table A.1: Interest Payments and Income - Logs and First Differences

The dependent variable is the change in the gross household income (columns 1 and 2), or natural logarithm of gross income (columns 3-6). The main independent variables are the amount of mortgage interests deducted from the taxable income (columns 3-4), its yearly change (columns 1-2), and natural logarithm of 1 + interests (columns 5-6). All columns use strongly balanced panel with individuals fixed effects with observations weighted by the inverse of the number of people in the household (1 or 2). Columns 1, 3, and 5 use only intensive-margin variation in the size of the mortgage, i.e., include only mortgage holders. Columns 2, 4, and 6 include all households. All columns include individual FE, previous income bin X age X year fixed effects, as well as county X year fixed effects. Standard errors are clustered on the household level. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	ΔGross Household Income		Log(Gross Household Income)			
	(1)	(2)	(3)	(4)	(5)	(6)
ΔInterests	0.324	0.291				
	(0.012)	(0.011)				
Interests /1000			0.0060	0.0050		
			(0.0002)	(0.0002)		
Log(1+Interests)					0.051	0.042
					(0.001)	(0.001)
N	1 714 450	98 195 970	1 707 900	97 068 194	1 707 900	97 068 194
Sample	Mortgage	All	Mortgage	All	Mortgage	All
Pr Inc-Age-Year FE	✓	✓	✓	✓	✓	✓
County-Year FE	✓	✓	✓	✓	✓	✓

Table A.2: Interest Payments and Income - Clustering by Year

This table is analogous to the main Table 3, but it clusters standard errors by year, as opposed to household. The main dependent variable is gross household income, and the main independent variable is the amount of interests paid. All columns include individual FE, previous income bin X age X year fixed effects, as well as county X year fixed effects. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Gross Household Income						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interests	0.166	0.337	0.347	0.348	0.297	0.459	0.348
	(0.104)	(0.027)	(0.031)	(0.032)	(0.062)	(0.060)	(0.162)
N	1885895	1714450	1714450	1714450	98195970	1714450	98195970
Sample		Mortgage Holders			All	Mrtg	All
Ind, Year FE	✓	✓	✓	✓	✓	✓	✓
Prev. Inc-Year FE		✓	✓	✓	✓	✓	✓
Pr Inc-Age-Year FE			✓	✓	✓	✓	✓
County-Year FE				✓	✓	✓	✓
IV						Reference Mortgage Size	Rate X
F-Stat						233.1	299.7

Table A.3: Interest Payments and Income - Additional Macro Controls

The dependent variable is the total gross household income. The main independent variable is the amount of mortgage interests deducted from the taxable income. All columns use strongly balanced panel with observations weighted by the inverse of the number of people in the household (1 or 2). Columns 1, 3, 5, and 7 use only intensive-margin variation in the size of the mortgage, i.e., include only mortgage holders. Columns 2, 4, 6, and 8 include all households. Each column includes an interaction of a quartile of mortgage size interacted with macroeconomic variable(s). In columns 2, 4, 6, 8 quartile of mortgage size is defined as zero for households with no mortgage. Macroeconomic variables are unemployment rate (columns 1-2), GDP growth rate (3-4), and change in CPI (5-6). Columns 7-8 include all three macroeconomic variables. All columns include individual FE, previous income bin X age X year fixed effects, as well as county X year fixed effects. Standard errors are clustered on the household level. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Gross Household Income							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Interests	0.358	0.299	0.350	0.317	0.333	0.298	0.341	0.320
	(0.022)	(0.021)	(0.022)	(0.020)	(0.022)	(0.021)	(0.022)	(0.021)
N	1714450	98195970	1714450	98195970	1714450	98195970	1714450	98195970
Sample	Mortgage	All	Mortgage	All	Mortgage	All	Mortgage	All
Macro Variables	Unemployment		GDP Growth		Inflation		All	
Pr Inc-Age-Year FE	✓	✓	✓	✓	✓	✓	✓	✓
County-Year FE	✓	✓	✓	✓	✓	✓	✓	✓

Table A.4: Interest Payments and Income - Alternative IV Specifications

This table presents specification analogous to columns 6-7 from the main Table 3 comparing results obtained for alternative choices of the instrumental variable. Columns 1-2 use household-level exposure interacted with WIBOR for all mortgages. Columns 3-4 use WIBOR, but only include mortgages denominated in Polish Zlotys. The results are presented only for the Instrumental Variable specifications, since in the OLS regression reference rate and mortgage size are not used and amount of interests paid is directly included. All columns include individual fixed effects and previous income bin X age X year fixed effects, and county X year fixed effects. Standard errors are clustered on the household level. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Gross Household Income			
	(1)	(2)	(3)	(4)
Interests	0.450	0.341	0.440	0.363
	(0.042)	(0.037)	(0.043)	(0.039)
N	1714450	98195970	1265260	97746780
Sample	Mrtg Hold	All	Mrtg Hold	All
Pr Inc-Age-Year FE	✓	✓	✓	✓
County X Year FE	✓	✓	✓	✓
IV - Wibor X Mrtg	✓	✓	✓	✓
Drop CHF Loans			✓	✓
F-Stat	$5.5{\cdot}10^4$	$7.6{\cdot}10^4$	$5.5{\cdot}10^4$	$7.6{\cdot}10^4$

Table A.5: Regressions of Interest Payments and Income from Different Sources.

This table is analogous to Table 7 in the main text, but dependent variables are in levels instead of logs. The estimates reflect both intensive and extensive margin variation of income from a given source and are influenced by the relative importance of different sources of income, documented in Table 1. Dependent variables are household wages (columns 1-2), pensions (3-4) and business profits (5-6). Main independent variable is the value of interests paid by the family in a given year expressed in thousands of Zloty. Columns 1, 3 and 5 include only mortgage holders, while columns 2, 4, 6 include all households. All columns include individual fixed effects, previous income bin X age X year fixed effects, county X year fixed effects, and fixed effects for the previous year value of the level of the dependent variable (wages rounded to nearest 10 tho.; pensions and profits rounded to nearest 5 tho.) Standard errors are clustered on the household level. Significance levels: *** - 0.01, ** - 0.05, * 0.1.

	Wages		Pensions		Profits	
	(1)	(2)	(3)	(4)	(5)	(6)
Interests	261.4	133.1	3.9	-3.7	40.2	17.8
/1000	(19.5)	(18.5)	(3.8)	(4.3)	(7.0)	(6.9)
N	1714450	98195970	1714450	98195970	1714450	98195970
Sample	Mrtg	All	Mrtg	All	Mrtg	All
Pr Inc-Age-Year FE	✓	✓	✓	✓	✓	✓
County-Year FE	✓	✓	✓	✓	✓	✓