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Abstract

This paper examines empirically the effect of the level of personal bankruptcy protection in the US on households' demand for financial assets. A Chapter 7 bankruptcy allows protecting the home equity up to a certain limit or "exemption". Previous literature shows that such exemption biases investment towards home equity. This paper tests whether it also lowers investment in stocks, which are not protected in bankruptcy. Using an instrumental variable approach, I estimate a lower stock market participation when the home equity is below the exemption, but the result is not robust, and households at higher risk of bankruptcy do not exhibit a stronger response. Moreover, investment in home equity is not higher when the home is fully protected. These findings suggest no substantial portfolio distortions from the level of home equity that is protected in bankruptcy.

JEL classification: D14; G00; G11; K35

Keywords: Personal bankruptcy law; Home equity protection; Stock market participation; Portfolio allocation

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1. Introduction

The personal bankruptcy law is one of the largest social programs in the US and the most generous bankruptcy law towards debtors in the world. On average 5 per 1,000 individuals have started a personal bankruptcy case per year between 1999 and 2011. Its generosity depends on the amount of resources that consumers can keep after filing for bankruptcy. Determining the optimal level of protection is a complex issue of great policy interest, given its potential welfare implications (Livshits et al., 2007; Dávila, 2020). Further, the bankruptcy law also specifies which resources can and cannot be protected from seizure by creditors. Such selectivity may have ex ante unintended consequences for the portfolio allocation of households.

Under Chapter 7, the most common choice to file for bankruptcy, households discharge most unsecured debt and retain their income. In exchange, they lose their assets, but the home equity, retirement accounts, vehicles, and bank deposits are protected up to a limit or exemption. Since homes are generally the main asset in households' portfolios, the home equity protection is effectively the largest. Corradin et al. (2016) documents that the so-called "homestead exemption" biases households' portfolios towards home equity.

This paper examines empirically a counterpart of that home equity bias. Specifically, it studies the impact of the homestead exemption in the demand for stocks held outside of retirement accounts—including those held via mutual funds or investment trusts—that are not protected in bankruptcy. I conjecture that when the homestead exemption becomes larger than the home equity, households' stock holdings will decline in response to a "substitution effect": Stocks are lost in bankruptcy and crowd-out investment in protected assets. This could result in a suboptimal portfolio allocation. Stocks offer higher liquidity than real estate and diversification gains, thanks to the low covariance of their returns with those of housing (Jordà et al., 2019).[2] Ultimately, addressing this question adds evidence on the effect of institutional factors on stock market participation. Their role is not well documented yet, despite that they are one of the explanations from the standard financial theory for the limited participation puzzle.

A simple portfolio choice model illustrates the proposed mechanism. The household can invest in home equity or in stocks after paying a fixed cost for participating in the stock market. A large negative wealth shock can occur with a positive probability. If the shock occurs,

[2] If the rates of return on stocks are higher than on housing, lower stock holdings may also lower the return on households' portfolios. Jordà et al. (2019) find evidence that their returns are similar in the long-run, but since World War II equities have outperformed housing on average.

the household defaults on its loans. In exchange, it loses the investment in stocks and any home equity that is above the homestead exemption. The model predicts that, conditional on wealth, the household holds more home equity and, hence, less stocks when the home equity is below the exemption level. In addition, if the exemption level is lower than household wealth, marginal increases in the exemption reduce stock market participation further. In both cases, the household response is driven by the purpose of increasing consumption in bankruptcy, which depends not only on the state exemption level but also on the pre-existing holdings of home equity.

To test the model predictions, I use longitudinal household data from the Panel Study of Income Dynamics (PSID) from 1999 to 2011. First, I examine if stock holdings are lower when the home equity is below the state exemption than when it is above. Given the endogeneity of housing wealth and financial assets, ordinary least squares (OLS) estimates may be biased. Thus, I construct a simulated instrument using nationally representative demographic groups, adapted from Currie and Gruber (1996) and Mahoney (2015). For every period, I compute an indicator of whether the average home equity of each group is below or above the exemption of each state. This removes the variation resulting from idiosyncratic shocks to households actually living in a given state. The benchmark specification compares households from the same state and with a similar level of home equity, changing from above to below the exemption (and vice versa). The resulting variation is mostly driven by changes in the exemption, which are plausibly exogenous—I verify that they are uncorrelated with changes in other factors that could potentially drive the demand for stocks. While this strategy removes most confounding factors, the results only provide suggestive evidence since the potential for omitted variable bias cannot be fully ruled out.

The evidence indicates that stock market participation and the dollar amount invested in stocks, conditional on participation, are lower when home equity is below than when it is above the exemption. However, these results are not robust to specifying the model in first differences in order to remove household-level heterogeneity. Moreover, I do not find a stronger response, neither at the extensive nor intensive margins, from households more at risk of bankruptcy (namely, the self-employed, households in bad health, and those with a middle-aged head). If stock holdings decline because of a substitution effect, the home equity should increase when the home becomes fully protected. Only the model in first differences renders a positive and significant effect on home equity, but not the one in levels. When I replicate the estimates in Corradin et al. (2016) using my simulated instrument, the effect turns out insignificant.

Next I examine if marginal increases in the exemption affect stock market participation.

A negative effect is expected only when the exemption is higher than the home equity but lower than the household's wealth. This turns out to be a stringent condition, since only few households have high wealth but low home equity relative to the state exemption. I exploit the fact that states set different levels of exemptions at different times, which allows dealing with the possible correlation between state exemptions and unobservable characteristics. Restricting the sample to high-wealth households and allowing for nonlinear marginal effects, I find a significant decline in participation at intermediate exemptions. For a one-standard deviation increase in exemptions, participation declines by 6 p.p., which represents a 15% change relative to the sample mean of the dependent variable (40%). However, no decline is estimated at higher exemptions and no stronger results are estimated for households at higher risk of bankruptcy. Not surprisingly, these findings suggest that marginal increases in the bankruptcy protection do not affect stock market participation.

This paper relates to the literature looking at the effects of insurance provision on household risk-taking and portfolio choice. Gollier et al. (1997) show theoretically that risk-taking is higher in the presence of a guaranteed minimum wealth or limited liability. Gormley et al. (2010) find a positive correlation between access to different types of formal insurance and participation rates. Studies specific to health insurance confirm its positive effect on stock holdings (Atella et al., 2012; Goldman and Maestas, 2013; Christelis et al., 2020). Bankruptcy protects against several risks, including that of medical expenses—in fact, it acts as an informal health insurance, as shown by Mahoney (2015). However, unlike that literature, this paper does not study whether the bankruptcy protection increases participation via a "consumption-floor effect".[3] While that mechanism is plausible, it may arise when comparing households with and without bankruptcy protection.[4] Instead, I study the impact of the generosity of Chapter 7 in a setting where all households have some bankruptcy protection. This paper also relates to the household finance literature that studies investment decisions in the presence of both housing and risky financial assets (Flavin and Yamashita, 2002; Cocco, 2004; Yao and Zhang, 2005; Chen and Stafford, 2016). Cocco (2004) uncovers a "background risk effect" wherein house price risk crowds out stock holdings. Here I do not examine the impact of real estate risk on the demand for financial risks, but whether

[3] Guaranteeing a minimum consumption in bankruptcy decreases exposure to background risk and this might increase the demand for risky assets (Elmendorf and Kimball, 2000). Background risk refers to sources of risk different from the volatility of the returns, such as labor and entrepreneurial income volatility, unemployment and out-of-pocket medical expenses. Even if these risks do not materialize, they can reduce the demand for risky financial assets ex ante (Kimball, 1993).

[4] In European countries, where consumer bankruptcy processes are less common and less generous than in the US, households not only hold less unsecured debt but also own less stocks than their US counterparts, even conditioning on characteristics (Christelis et al., 2013, 2017).

protecting home equity from seizure in bankruptcy has a substitution effect on unprotected stocks.

This paper builds on the literature showing that the state exemptions impact on the financial benefit from filing and, ultimately, on households' bankruptcy decisions. The evidence on the effect of exemptions on the decision to file for bankruptcy is mixed; some studies find no effect (Lefgren and McIntyre, 2009) and others a positive effect (Fay et al., 2002; Agarwal et al., 2003; Lehnert and Maki, 2007; Miller, 2019).[5] The result in Miller (2019) that such positive effect is increasing in households' assets gives plausibility to the mechanisms proposed here. This paper complements another important strand of the bankruptcy literature, which studies how it influences entrepreneurship decisions.[6] Its most direct contribution is to the strand considering the effects of the bankruptcy protection on the composition of borrowing (Gropp et al., 1997; Severino and Brown, 2017) and on asset allocation (Greenhalgh-Stanley and Rohlin, 2013; Corradin et al., 2016). Greenhalgh-Stanley and Rohlin (2013) find a positive impact of that protection on the housing wealth of older households. However, they estimate a stronger response when the home equity is high and, therefore, more likely to be above rather than below the exemption, as predicted here. When the home equity is below the exemption, Corradin et al. (2016) find a larger investment in home equity in response to an increase in household wealth. The findings in Corradin et al. (2016) are consistent with my predictions.

One possible reason for the lack of evidence on stock holdings is that the PSID data have little statistical power to capture that effect. However, it is striking that I do not even find a significant effect on home equity, where statistical power is less of a concern according to the test proposed by Burlig et al. (2020). If power is low even for home equity (Corradin et al., 2016, use data from the Survey of Income and Program Participation, or SIPP, which samples a larger number of households), my results suggest that the home equity bias is not of first order to show up in a representative survey of US households. On the other hand, my empirical strategy enhances the estimates by Corradin et al. (2016) in several dimensions, challenging the existence of such bias. First, they instrument the indicator for home equity being below the exemption with the exemption level in 1920. I instead build a time-varying instrument from nationally representative groups that deals with the main source of endogeneity coming

[5]In the theoretical literature, Athreya (2006), Pavan (2008), Lopes (2008), Mankart (2014), and Mankart and Rodano (2015) predict a positive relationship, whereas Li and Sarte (2006) and Mitman (2016) predict a negative one.

[6]See, e.g., Berkowitz and White (2004); Berger et al. (2011); Fossen (2014); Mankart and Rodano (2015); Cerqueiro and Penas (2016).

from changes in home equity.

Second, they provide evidence of heterogeneous effects by showing a slightly larger response from households in bad health and younger. I test for significant differences across groups, which provides more convincing evidence, and look at middle-aged households, which are the ones more at risk of bankruptcy according to Fisher (2019). Third, the authors study whether investment in housing is differently affected by changes in household wealth when the home equity is below the exemption. While intuitively plausible, this adds an additional source of endogeneity.[7] I investigate the pure effect of having home equity below the exemption, conditioning on wealth. This mitigates the possibility of estimating a spurious positive relationship, for instance, if the elasticity of home equity investment to wealth changes is larger when the home equity is low. In summary, these considerations, along with my findings, cast doubts on a home equity bias attributed to the bankruptcy protection. The absence of such bias in the first place can account for why the bankruptcy protection has no effect on stock holdings.

2. US Personal Bankruptcy Law

Individuals smooth consumption over the life-cycle by taking loans in the presence of uncertainty. If income turns out to be low or expenses high, individuals would have to reduce consumption dramatically or will not be able to meet their financial obligations. In that context, the bankruptcy law has two main conflicting functions. One is to act as a consumption insurance, by allowing debtors to discharge most unsecured debt, including credit card debt, installment loans, and medical bills. Debts that are not dischargeable include tax obligations, student loans, alimony, child support obligations, debts incurred by fraud, credit card debt incurred just before filing, and some secured debt such as mortgages and car loans.[8] The second function of the bankruptcy law is to discourage households from borrowing without considering if they are or will remain solvent. This is achieved by imposing costs for defaulting, which include future exclusion from credit markets, the ban to file again for several years, and filings becoming public knowledge and appearing on credit records for ten years. In exchange for discharging debt, there are two repayment options. Under Chapter 13, house-

[7] In turn, wealth changes can affect the probability of having home equity below the exemption (both are measured at period t). Thus, adding their interaction gives rise to the "bad control" problem (Angrist and Pischke, 2009).

[8] Even after filing for Chapter 7 the borrower has to continue making mortgage payments, otherwise the lender can foreclose the house. However, Chapter 7 prevents the lender from going after the borrower's personal assets when the house is sold through foreclosure and the sale proceeds are lower than the mortgage balance.

Table 1: **Average exemption levels for couples and singles, 1999-2011**

	Average exemption (excl. states with unlimited exemption) ($)		States with unlimited exemption	Average home equity ($)	
	Couples	**Singles**		**Couples**	**Singles**
1999	77,163	50,324	AR, FL, IA, KS, OK, SD, TX	55,496	19,636
	(75,835)	(63,950)		(31,182)	(17,609)
2001	71,226	47,022	AR, DC, FL, IA, KS, OK, SD, TX	65,492	28,707
	(66,021)	(55,491)		(38,353)	(38,662)
2003	68,654	48,535	AR, DC, FL, IA, KS, OK, SD, TX	74,081	33,462
	(69,725)	(66,676)		(54,306)	(33,402)
2005	69,736	49,486	AR, DC, FL, IA, KS, OK, SD, TX	78,886	30,858
	(85,598)	(80,526)		(54,732)	(22,370)
2007	76,588	53,449	AR, DC, FL, IA, KS, OK, SD, TX	82,230	32,278
	(96,096)	(90,435)		(56,094)	(23,628)
2009	112,992	92,429	AR, DC, FL, IA, KS, OK, SD, TX	64,878	28,716
	(157,834)	(159,664)		(38,236)	(41,354)
2011	134,152	109,009	AR, DC, FL, IA, KS, OK, SD, TX	61,677	20,050
	(180,337)	(185,462)		(40,312)	(21,870)
1999-2011	87,183	64,943		68,963	27,634
	(114,030)	(113,642)		(46,199)	(29,931)

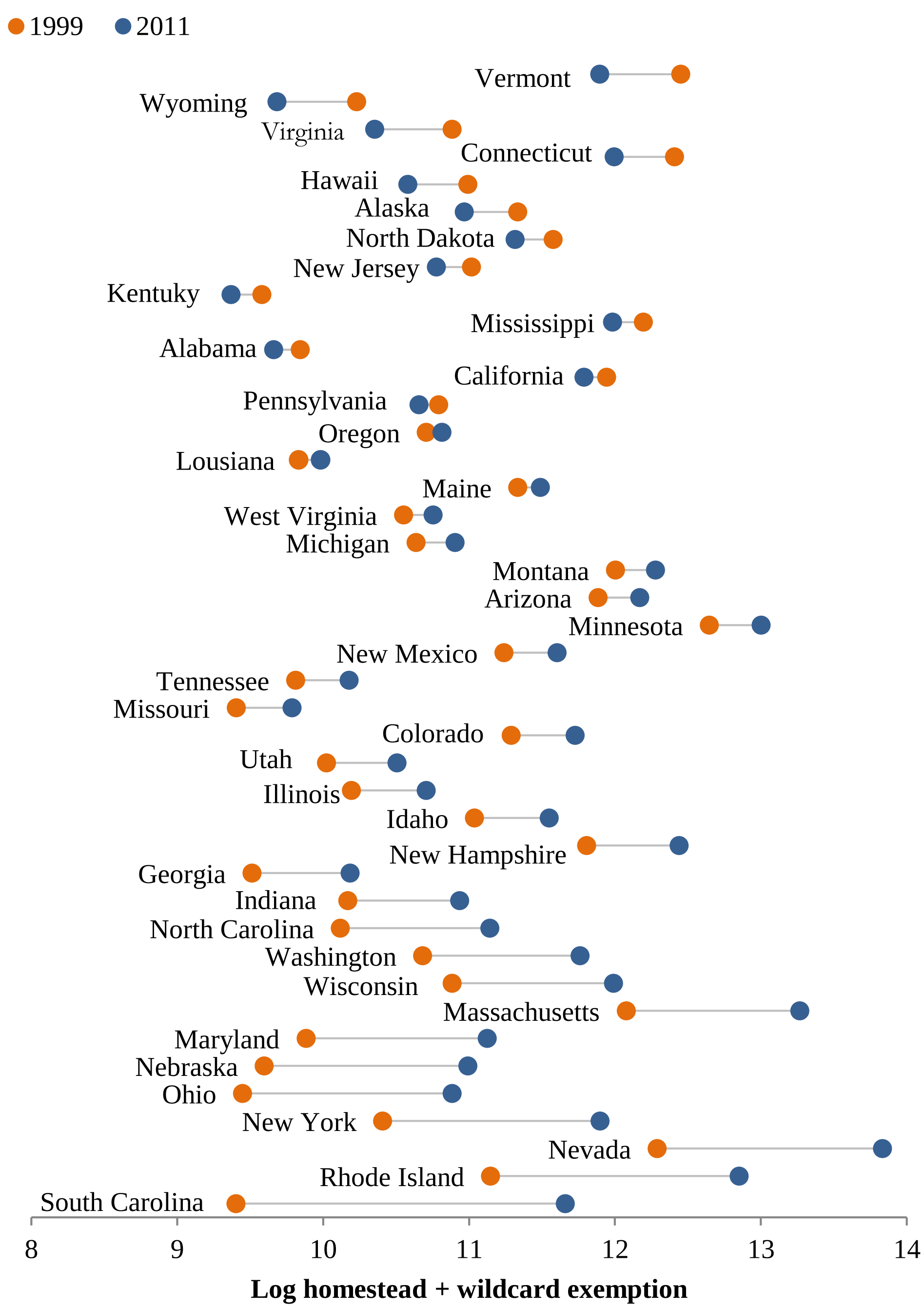
Notes. This table shows the average homestead plus wildcard exemption levels for couples and singles in real 2004 dollars (deflated using the state house price index) for states with no unlimited homestead exemption. States with unlimited homestead exemption by year are listed in the middle column. The last two columns report the average home equity for couples and singles in real 2004 dollars. Standard deviations are reported in parenthesis. Data are extracted from bankruptcy filing manual books (Renauer et al., several editions).

holds pay out of post-bankruptcy income over the following three to five years but can keep all their assets. Under Chapter 7, debtors lose their assets but can keep future income. To provide extra insurance to households, Chapter 7 sets exemptions for some asset categories. Goodman (1993) explains that the asset exemptions emerged during the second half of the nineteenth century to attract population into uninhabited areas. Regions more interested in attracting potential settlers set higher exemptions. The exempt assets usually comprise equity in owner-occupied homes, vehicles, retirement assets, and bank deposits. Some states also have "wildcard exemptions" that can be used to protect non-exempt assets or assets in excess of the corresponding exemption. The exemptions vary by state and marital status, and on occasions also by age (65 or over) and disability status. Some states give the option to file under the exemptions set by the federal law.

During the period from 1999 to 2011, the Chapter 7 exemptions have experienced substantial variation over time. Table 1 shows that the average (homestead plus wildcard) exemption for couples increased from $77,163 in 1999 to over $134,000 in 2011 (in real 2004 dollars). Washington DC was the only state that changed to an unlimited homestead exemption over those years, starting from the federal level. Differences in exemption levels across states are also very large, as reflected in the large standard deviations. For each state, Figure 1 shows the logarithm of those exemptions in 1999 and 2011. Since some states, such as Vermont, Wyoming, Virginia, exhibit little or no variation in nominal values, they experience a decline in real terms over that period. In others, such as Oregon, Louisiana and Maine, the increase in nominal terms was just enough to account for the increase in home prices. In contrast, the increase of those at the bottom of the figure, such as Nevada, Rhode Island and South Carolina, has been substantial.

Under Chapter 7, unsecured debt is discharged by the end of the case. "Asset cases" are those in which the filer owns non-exempt assets (i.e. assets above the corresponding exemption or from non-exempt categories), which become property of the bankruptcy estate by the time of filing. A trustee assigns a dollar amount to the non-exempt assets and divides the funds among creditors. In the more common "non-asset cases", the filer does not own non-exempt assets. Asset cases usually close about two years after filing and non-asset cases close within four months. The practice of selling any non-exempt asset before filing, known as "bankruptcy planning", is discouraged by the law when its purpose is to defraud creditors. Proceeds can still be used to pay the attorney and other filing fees. Table 1 shows that the average home equity level was below the average exemption for both couples and singles between 1999 and 2011—only in 2003, 2005 and 2007 it was above the average exemption for couples.

Figure 1: Logarithm of state exemption levels for couples, 1999-2011 (2004 USD)



Notes. This figure shows the logarithm of the sum of the homestead plus wildcard exemptions in 1999 and 2001 in real 2004 dollars (deflated using the state house price index). It excludes states with unlimited homestead exemptions (Arkansas, Florida, Iowa, Kansas, Oklahoma, South Dakota, Texas and District of Columbia) and Delaware that was an outlier for the first years of the sample. Data are extracted from bankruptcy filing manual books (Renauer et al., several editions).

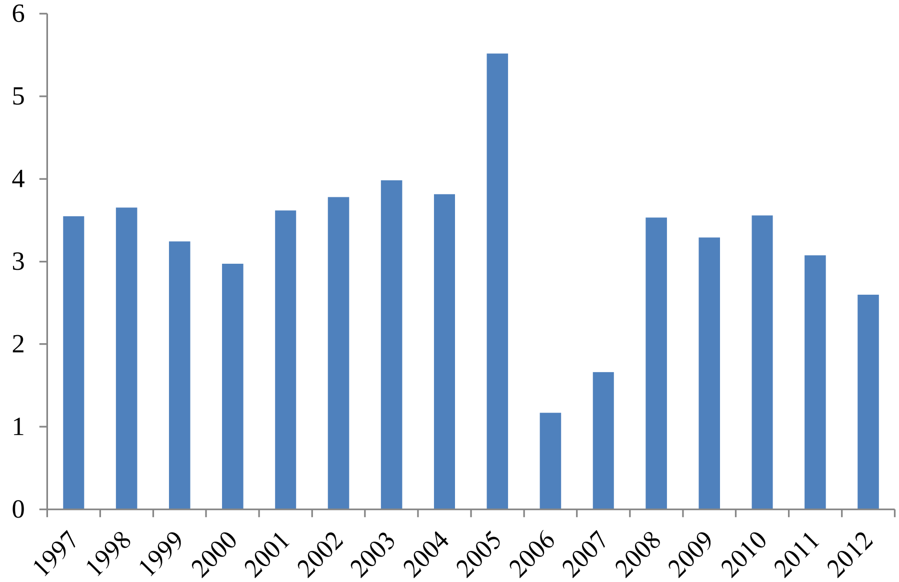
Before 2005 debtors could choose under which chapter they wanted to file, and the most common choice was Chapter 7. Thus, even defaulters with very high incomes were not committed to future repayments. Under Chapter 13 borrowers repay from post-bankruptcy income, a less attractive alternative. This system encouraged strategic behavior and became beneficial for individuals with high income and wealth. In addition, Chapter 13 filers were able to propose their own repayment plans and typically proposed an amount equal to the value of their non-exempt assets: They were not allowed to repay less and since they had the option to choose Chapter 7, they had no incentives to repay more (White, 2007). This means that even for those who decided to file under Chapter 13, Chapter 7 exemptions would still affect the repayment amount and therefore the probability of declaring bankruptcy.

In 2005 there was a reform in the law, known as the "Bankruptcy Abuse Prevention and Consumer Protection Act of 2005" (BAPCPA). Its purpose was to restrict the speculative behavior that led to historically high levels of bankruptcy. The reform removed the debtor's right to choose between Chapters 7 and 13. In order to qualify for Chapter 7, debtors need to pass a "means test", except for the self-employed with mostly business debt and for certain members of the military. To pass that test, the annualized average income over the six months before filing needs to be smaller than the state median income. Otherwise, the "disposable income" needs to be smaller than a certain amount.[9] Thus, high-income households have to file under Chapter 13 and can no longer propose their own repayment plans under that chapter. The reform also increased the costs of filing under both chapters and extended the minimum time that debtors must wait before filing again. In addition, it introduced a new exemption for tax-protected individual retirement accounts (up to $2 million for couples and $1 million for singles).

Figure 2 shows that the number of Chapter 7 filings was on average 3.6 per 1,000 inhabitants between 1997 and 2004. That figure increased by more than 50% to 5.5 in 2005, when debtors who anticipated going bankrupt had an incentive to file before the new law was implemented. After the reform, the number of filings plummet to just 1.2 in 2006 and then started to rise, reaching the pre-reform levels by 2008.

[9]"Disposable income" is the difference between debtors' average monthly family income during the six months prior to filing and a new income exemption, which determines an allowance for living expenses.

Figure 2: Number of Chapter 7 filings per capita by year



Notes. The columns show the number of non-business Chapter 7 filings per 1,000 inhabitants (annual averages) extracted from the Statistics Division of the Administrative Office of the United States Courts.

3. Theoretical Framework and Empirical Predictions

3.1. A model of portfolio choice with bankruptcy

To derive the empirical predictions, this section presents a two-period model of household portfolio choice in the presence of a bankruptcy protection similar to that from Chapter 7. The household starts the first period with initial wealth W that can invest in two asset categories, home equity (h) and a risky financial asset (s). If it invests in the risky asset, it faces a fixed cost of stock market participation, q.[10] The net return on h equals 0 and on s is random and equals $r_{high} > 0$ with probability $p > 0$ and $-r_{low} < 0$ with probability $1 - p$.[11] I define the stock premium as the difference in the expected net returns of s minus h and assume that it is positive to induce stock market participation, that is, $pr_{high} - (1 - p)\, r_{low} > 0$.

In the second period, the household faces a large negative wealth shock and declares

[10] Fixed costs of entry and participation into the stock market are assumed, for example, by Vissing-Jorgensen (2002), Haliassos and Michaelides (2003), Gomes and Michaelides (2005) and Alan (2006).

[11] Even though housing is also a risky asset, it can be assumed as safer than equities. Jordà et al. (2019) show that its return has a lower volatility and lower covariance with consumption growth than the return on equities. Corradin et al. (2016) assume that non-housing assets have higher returns than housing and that both are safe assets.

bankruptcy with probability ε. Further, I assume that ε is uncorrelated with p (the shock can occur, for instance, if an unexpected illness leads to a substantial increase in medical expenses or if the individual becomes unemployed and experiences a large loss of future income). If the shock occurs, the household does not have to repay its loans and second-period expenses are zero rather than positive. In exchange, it loses all the investment in the risky asset, whereas it can guarantee a minimum level of consumption given by h, up to a maximum of $\overline{H} > 0$. With probability $1-\varepsilon$, the household does not face that major shock and, therefore, does not declare bankruptcy.

The optimal level of stocks denoted by s^* includes the possibility of nonparticipation (i.e., $s^* = 0$). If $s^* = 0$, the household invests all its wealth into home equity, $h^* = W$, and consumption in the second period equals W with probability $1-\varepsilon$ and $\min\left(W, \overline{H}\right)$ with probability ε. Thus, when the bankruptcy exemption $\overline{H}$ is low, the household consumes its initial wealth in the good state and $\overline{H}$ in the bad state. When that exemption is high, it consumes its initial wealth in both states.

If $s^* > 0$ and assuming that the utility function is of logarithmic form, $U(C) = \log(C)$, in the first period the household chooses h and s to solve the problem given by:

$$\max_{h,s} E\left[\log(C)\right] \tag{1}$$

subject to the following constraints:

$$h + s + q \leq W \tag{2}$$

$$C = \begin{cases} h + (1 + r_{high})s & 1-\varepsilon, p \\ h + (1 - r_{low})s & 1-\varepsilon, 1-p \\ \min\left(h, \overline{H}\right) & \varepsilon \end{cases} \tag{3}$$

$$C \geq 0 \tag{4}$$

$$h \geq 0 \tag{5}$$

$$s \geq 0 \tag{6}$$

where I assume that the time discount rate equals 1 without loss of generality. The budget constraint in equation (2) will hold with equality, given the assumption of nonsatiation. Condition (3) gives the three possible consumption levels with their corresponding probabilities in the second column. The inequality in (4) is never binding since $\lim_{C \to 0} \frac{1}{C} = \infty$. The constraints in (5) and (6) reflect the assumption that the quantities of the two assets held are nonnegative. They ensure that the share of wealth invested in the risky asset is bounded between 0 and 1. If the constraint (5) were binding, the condition (3) implies that $C = 0$ with probability ε. Thus, home equity at a corner of zero cannot be optimal since $\lim_{C \to 0} \frac{1}{C} = \infty$. In turn, since the household participates in the stock market, the condition (6) is not binding. The solution to the problem given by equations (1) to (6) is denoted as s^{**}, which is the optimal level of stock holdings conditional on participation.

I denote by V^{in} and V^{out} the indirect utilities of households that participate and do not participate in the stock market, respectively. The household participates when it gives higher utility than investing purely in home equity:

$$V = \max_{\mathbb{1}(s^* > 0)} \left[V^{in}, V^{out} \right] \tag{7}$$

where $\mathbb{1}(s^* > 0)$ is an indicator function that equals 1 if the household participates in the stock market and 0 otherwise. The indirect utility of not participating equals $V^{out} = (1 - \varepsilon) \log (W) +$ $+ \varepsilon \log \left(\min \left(W, \overline{H} \right) \right)$. Under these conditions, I obtain the following proposition:[12]

Proposition 1. *For a given level of wealth, the probability that the household participates in the stock market is smaller when the home equity, conditional on participation, is fully protected in bankruptcy than when it is not. This effect is increasing in the probability of bankruptcy.*

The household never participates in the stock market for high q and always participates for low q. For the same wealth level, an increase in $\overline{H}$ that moves the solution from the region where $h^{**} \geq \overline{H}$ to that where $h^{**} < \overline{H}$ reduces the threshold for q that determines participation. This leads to Proposition 1, which implies that participation is lower when the exemption level becomes high relative to the home equity, conditional on participation. The lower participation when $h^{**} < \overline{H}$ occurs because holding s reduces h and, therefore, reduces consumption in bankruptcy. This effect is larger when the probability of bankruptcy is higher. Marginal changes in the bankruptcy exemption can also affect the participation decision, as stated by the following proposition:

Proposition 2. *Marginal increases in the exemption reduce the probability of participation when the exemption is larger than the optimal home equity, conditional on participation,*

[12] All proofs can be found in Appendix B.

but smaller than the wealth level, $h^{**} < \overline{H} < W$. This effect is stronger when the probability of bankruptcy is larger.

Proposition 2 allows identifying three regions. When $h^{**} \geq \overline{H}$, increases in the exemption do not affect the probability of participation; they lead to higher consumption in bankruptcy irrespective of whether the household holds stocks. An increase in $\overline{H}$ that leaves the home fully protected, $h^{**} < \overline{H}$, reduces discretely the probability of participation, as stated by Proposition 1. Proposition 2 predicts that it continues declining as the exemption increases further; in that region, holding stocks prevents increasing consumption in bankruptcy as the exemption becomes larger. The higher the probability of a negative shock, ε, the more decreases the probability of participation. At high exemptions, when $\overline{H} > W$, participation is no longer affected by marginal increases in the exemption; the household has already invested all its wealth in the protected asset. Finally, the third proposition describes the optimal investment decision at the intensive margin in the presence of bankruptcy protection:

Proposition 3. *For a given level of wealth, if the stock premium is smaller than $r_{high} \times r_{low}$, the optimal value invested in stocks (s^{**}), conditional on participation, is smaller when the home equity is fully protected in bankruptcy ($h^{**} < \overline{H}$) than when it is not. In addition, when $h^{**} < \overline{H}$, s^{**} is decreasing in the probability of bankruptcy.*

Proposition 3 states that, when the expected return of the financial asset is low, an increase in $\overline{H}$ that moves the solution from the region where $h^{**} \geq \overline{H}$ to that where $h^{**} < \overline{H}$ increases the attractiveness of investing in home equity and, therefore, reduces investment in stocks at the intensive margin. If the expected return of the financial asset is high, investment in that asset will always be high and no decline is expected following an increase in $\overline{H}$. The second part of Proposition 3 says that, when $h^{**} < \overline{H}$, a higher probability of a negative shock reduces the amount invested in the financial asset, since it reduces its marginal benefit and increases its marginal cost. When $h^{**} \geq \overline{H}$, that effect is not expected because the household cannot increase consumption in bankruptcy by investing more in home equity.

I illustrate the former predictions with an example, using a standard parameterization. I consider the case where r_{high}=1 and $r_{low} = 1$, which corresponds to net returns $(1, -1)$, similar to the sum of two "Arrow-Debreu" assets. The resulting stock premium, $2p - 1$, is positive whenever $p > 0.5$, so I set $p = 0.75$. I assume that the wealth level equals the average wealth in the sample, $W = 200$ (in thousands), and that the participation cost equals $q = 10$. Table 2 shows the results at different exemption levels, for $\varepsilon = 0.05$ in the middle section and for $\varepsilon = 0.15$ in the bottom section.

The middle section shows that q^I, the threshold for q above which the household does not participate in the stock market, does not change when the exemption goes from $\overline{H} = 50$ to $\overline{H} = 80$ and the home is not fully protected ($h^{**} = 95$). When the home becomes fully protec-

Table 2: Numerical example

	$\overline{H} = 50$	$\overline{H} = 80$	$\overline{H} = 150$	$\overline{H} = 180$	$\overline{H} = 200$	$\overline{H} = 250$
r_{high}	1	1	1	1	1	1
r_{low}	1	1	1	1	1	1
p	0.75	0.75	0.75	0.75	0.75	0.75
W	200.0	200.0	200.0	200.0	200.0	200.0
q	10.0	10.0	10.0	10.0	10.0	10.0
ε	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**
h^I	87.7	87.7	103.3	77.0	77.4	77.4
s^I	87.7	87.7	76.3	104.2	104.8	104.8
q^I	24.5	24.5	20.4	18.8	17.8	17.8
h^{**}	95.0	95.0	109.3	109.3	109.3	109.3
s^{**}	95.0	95.0	80.8	80.8	80.8	80.8
ε	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**	**0.15**
h^I	87.7	87.7	133.7	137.4	139.6	139.6
s^I	87.7	87.7	50.7	52.1	52.9	52.9
q^I	24.5	24.5	15.6	10.5	7.5	7.5
h^{**}	95.0	95.0	137.8	137.8	200.0	200.0
s^{**}	95.0	95.0	52.3	52.3	0.0	0.0

Notes. This table shows a numerical example for the predictions of the theoretical model in section 3.1. Each column corresponds to a different exemption level, $\overline{H}$. r_{high} and $-r_{low}$ denote the net rates of return on the risky asset, p is the probability of a high return and W is the wealth level. q is the participation cost so that the household participates if $q < q^I$ and does not participate otherwise. ε is the probability of a negative wealth shock. h^I and s^I are the levels of home equity and stock holdings corresponding to a participation cost of q^I that equalizes the expected utility of participating and non-participating. h^{**} and s^{**} are the optimal investment in home equity and in stocks conditional on participation for a given cost q. All dollar values are expressed in thousands. The center panel presents the results assuming $\varepsilon = 0.05$ and the bottom panel the results for $\varepsilon = 0.15$. The parameters in the top panel are used for both sets of results.

ted at $\overline{H} = 150$, q^I declines, which implies a lower participation as predicted by Proposition 1. q^I keeps declining as $\overline{H}$ increases to 180 and then to 200, as predicted by Proposition 2. It remains the same at exemption levels beyond $\overline{H} = 200$, that is, beyond the wealth level, W. In turn, the optimal level of stocks conditional on participation declines from $s^{**} = 95$ when the home is not fully protected to $s^{**} = 81$ when it becomes fully protected following an increase in $\overline{H}$, as predicted by Proposition 3. Finally, the bottom section presents the results for $\varepsilon = 0.15$. When the exemption is low, $\overline{H} = \{50, 80\}$, the results are the same as when $\varepsilon = 0.05$. But the declines in q^I and s^{**} after the home equity becomes fully protected are more pronounced, consistent with the predicted higher sensitivity of households more at risk of bankruptcy at both the extensive and intensive margins.

3.2. Empirical predictions

Propositions 1 to 3 predict that a higher homestead exemption under Chapter 7 has a non-linear, negative effect on the demand for stocks outside retirement accounts, which are lost in bankruptcy. The non-linearity comes from the fact that the effect of the bankruptcy exemption depends on the household's wealth level and on how much of that wealth is invested in home equity.[13]

On the basis of the propositions of section 3.1, I state the main hypotheses that will guide the empirical tests in section 5.

- Hypothesis 1. Conditional on household's wealth, the probability of participating in the stock market is smaller when the home equity is fully protected in bankruptcy than when it is not. That differential is increasing in the probability of bankruptcy.

- Hypothesis 2. The probability of participating in the stock market is decreasing in the exemption level when that level is higher than the home equity but lower than the household's wealth. This effect is stronger when the probability of bankruptcy is larger.

- Hypothesis 3. Conditional on household's wealth and on stock market participation, investment in stocks is smaller when the home equity is fully protected in bankruptcy than when it is not. That investment is decreasing in the probability of bankruptcy when the home

[13]Propositions 1 to 3 predict no positive income effect on the demand for stocks from the bankruptcy protection. However, it can be shown the presence of a positive consumption floor effect on participation relative to a setting without such protection. In the absence of bankruptcy protection, the household has to repay a large negative wealth shock, $-D < 0$, in the second period. As a result, the third row of the budget constraint in (3) changes to $C = h + (1 + r_{high})s - D$ with probabilities ε and p and to $C = h + (1 + r_{high})s - D$ with probabilities ε and $1 - p$. The value of q that leaves the household indifferent between participating or not in the stock market is smaller than the values derived in Proposition 1. Thus, the region where non-participation is optimal is larger in the absence of bankruptcy protection. This result, however, cannot be tested empirically exploiting cross-state variation in the US, given the ubiquity of the Chapter 7 protection.

equity is fully protected.

4. Data and Sample Definition

The source of household data is the PSID, a longitudinal panel survey that is representative of the entire population of the United States and their families. It has detailed information on portfolio composition, publicly available state identifiers, and household socio-demographic characteristics.[14] Asset holdings are from the wealth survey, conducted every other year since 1999. Thus, I define the sample for the period between 1999 and 2011. It is restricted to households where the head is 65 years old or younger in every year—households hold more conservative portfolios as they age and are less likely to file for bankruptcy. After excluding observations where some of the regressor variables are missing, the final sample has 46,454 observations corresponding to 50 states plus Washington, D.C.

Table 3 reports descriptive statistics for all household and state variables (see Appendix Table A.1 for definitions). The statistics are reported for the entire sample and, separately, for households with home equity below and above the (homestead plus wildcard) exemption level in a given year. This sample split means that households can change their classification over the period. About 70% of the observations have home equity below the exemption.

Table 3: Summary statistics, 1999-2011

	All households	**Below exemption**	**Above exemption**
	N = 46,454	***N = 33,046***	***N = 13,408***
Panel A: Household-level data			
Stock market participation	0.17	0.11	0.31
	(.37)	(.31)	(.46)
log(Stocks) ($)	9.87	9.25	10.39
	(2.14)	(2.19)	(1.94)
IHS(Home equity) ($)	10.37	8.53	12.09
	(4.82)	(6.38)	(.90)
IHS(Wealth) ($)	7.40	5.32	12.51
	(8.05)	(8.55)	(2.71)

[14] The PSID offers more tractability for panel data analysis than the SIPP, which is composed of a series of multiyear panels and, hence, does not track the same households through an extended period.

	All households *N = 46,454*	Below exemption *N = 33,046*	Above exemption *N = 13,408*
IHS(Income) ($)	9.70	9.44	10.33
	(3.63)	(3.66)	(3.46)
log(Age of the head) (years)	3.66	3.60	3.82
	(.31)	(.31)	(.24)
College education	0.49	0.45	0.59
	(.50)	(.50)	(.49)
Highest year of college	1.48	1.28	1.97
completed	(1.81)	(1.71)	(1.95)
Married	0.59	0.52	0.75
	(.49)	(.50)	(.43)
log(Family size)	0.88	0.85	0.98
	(.57)	(.59)	(.50)
Self-employed	0.10	0.08	0.13
	(.30)	(.28)	(.33)
Bad health	0.14	0.15	0.10
	(.34)	(.36)	(.30)
Age 35-49 years old	0.39	0.37	0.43
	(.49)	(.48)	(.5)
Panel B: State-level data			
log(Exemption) ($)	11.31	11.75	10.22
(excl. unlimited)	(2.20)	(2.41)	(.86)
Unlimited exemption	0.16	0.23	0.00
	(.37)	(.42)	-
log(Inflation-adjusted	-0.10	-0.11	-0.08
house price)	(.17)	(.17)	-
log(Unemployment rate)	-2.82	-2.80	-2.86
	(.36)	(.37)	(.34)
log(Proprietor employment)	13.68	13.70	13.65
	(.85)	(.9)	(.71)
log(Per capita personal	10.42	10.41	10.43
income) ($)	(.14)	(.15)	(.14)

	All households	**Below exemption**	**Above exemption**
	N = 46,454	***N = 33,046***	***N = 13,408***
log(State GDP) ($)	12.79	12.78	12.81
	(.89)	(.93)	(.77)
log(Nr. of non-business	1.49	1.47	1.54
bankruptcy filings/1,000 inh.)	(.46)	(.46)	(.44)
log(Per capita medical	8.56	8.56	8.56
expenses) ($)	(.16)	(.17)	(.15)

Notes. Household-level data correspond to household heads in the 1999 to 2011 PSID panels, 65 years old or younger. The first column includes all the sample and the next two columns split the sample in households with home equity below and above the (homestead plus wildcard) state exemption in year t. Monetary values are in real 2004 dollars and winsorized at the 1st and 99th percentile. All variables are described in Appendix Table A.1. Standard errors are in parentheses.

Panel A shows households' asset holdings and socio-demographic characteristics. Only 11% of households with home equity below the exemption hold stocks outside retirement accounts on average, versus 31% of those with home equity above the exemption. The measure of stocks includes those invested in publicly held corporations, mutual funds, or investment trusts, and excludes those invested into individual retirement accounts. Retirement accounts can be subject to deposit limits and to penalties from early withdrawal and are protected from bankruptcy up to $1 million since 2005 (subject to cost-of-living adjustments). Conditional on ownership, the amount held in stocks is also significantly lower for households below the exemption. One caveat is that the dollar amount held in stocks generally suffers from high measurement and reporting errors in survey data (Fagereng et al., 2017). In addition, at the intensive margin, passive variations in the value of stocks may conceal active rebalancing decisions made by households (Calvet et al., 2009). These issues apply to survey data in general and, hence, are not unique to the PSID.

Panel A also shows that households on average have lower wealth and income when their home equity is below than above the exemption. I take the inverse hyperbolic sine (IHS) transformation of home equity, wealth and income to preserve observations with negative or zero values (not possible with a logarithmic transformation), as recommended by Burbidge et al. (1988). In addition, households with home equity lower than the exemption are younger, less likely to have some college education, and have less years of college on average than those with home equity above the exemption. They are less likely to be married and live in households with fewer family members. Finally, they are less likely to be self-employed and to have a middle-aged head, and more likely to be in bad health. Being self-employed, middle-aged, and in bad health are positively correlated with a higher likelihood of filing for bankruptcy.

Panel B of Table 3 shows summary statistics for the state-level data. The state exemptions were extracted from bankruptcy filing manual books (Renauer et al., several editions). I only include homestead plus wildcard exemptions, which represent on average about 90% of the total asset exemptions (i.e., after adding exemptions for vehicles, business wealth, and other real estate). The summary statistics for the levels and changes in exemptions are only computed for states with no unlimited homestead exemption. For the regressions, whenever the homestead exemption is unlimited, I set the corresponding value to the maximum level of home equity ever observed in the sample. The third row of Panel B shows that on average 16% of the entire sample and 25% of the households in the below-the-exemption group live in states with unlimited protection. By definition, there is no household in the above-the-exemption group living in those states.

The state level variables used as controls are taken from Freddie Mac (the house price index), the Bureau of Labor Statistics (BLS) (unemployment rate), the Bureau of Economic Analysis (BEA) (proprietor employment, per capita personal income, real GDP), the Statistics Division of the Administrative Office of the US Courts (non-business bankruptcy filings), and the Centers for Medicare & Medicaid Services (CMS) (per capita medical expenses). Data on medical expenses are available only until 2009. I deflate all nominal values by the BLS Consumer Price Index (CPI) (2004 = 100), using the index for urban consumers as a proxy for the state-level index.

5. Empirical Analysis

5.1. Stock market participation after the home equity becomes fully protected

5.1.1 Empirical strategy

In this section I test for the first hypothesis that households are less likely to participate in the stock market when their home equity becomes fully protected under Chapter 7. I estimate the following model:

$$S_{ist} = \alpha_0 + \alpha_1 Below_{ist-1} + \alpha_2 X_{ist} + \alpha_3 R_{st} + \alpha_t + \alpha_{s,t} + \alpha_s \times \alpha_h + \nu_{ist} \tag{8}$$

where S_{ist} is a dummy indicating whether household i, living in state s in year t owns stocks. That is, we observe $S_{ist} = 1$ if $S^*_{ist} > 0$ and $S_{ist} = 0$ if $S^*_{ist} = 0$, where S^*_{ist} is a continuous latent variable. $Below_{ist-1}$ is a dummy that takes the value of 1 if household i, living in state s in year $t-1$, has home equity below the exemption of that state and year and of 0 otherwise. Under Hypothesis 1, α_1 should be negative if participation declines when the home equity is below the exemption. In the baseline specification, the coefficients are estimated using an OLS model.[15] The error term, v_{ist}, absorbs the idiosyncratic variation in stock ownership across households, states, and time. Since the effect of being below the exemption is likely to be correlated within a state, I cluster the standard errors at the state level.

I follow the literature by including time-varying control variables with a demonstrated effect on participation (see, e.g., Guiso et al., 2008; Giannetti and Wang, 2016). The set of socio-economic and demographic controls, X_{ist}, includes restricted cubic splines of the IHS transformation of household wealth and labor income to capture nonlinearities in the wealth and income effects, dummies for whether the head is married and for whether has some college education, and the logarithm of the head's age and family size. I control for state-level variables in R_{st} to reflect economic conditions, including proprietor employment and state house prices deflated by the CPI. The latter accounts for the fact that the conditions in the housing market could be correlated with the bankruptcy protection and drive participation via wealth effects (Chen and Stafford, 2016).

The constant α_0 measures aggregate financial parameters (such as the risky asset premium). The model also includes a time dummy to control for factors that affect the entire cross-section of individuals in any given year (α_t). This responds to a common identifying assumption in this literature that there are age and time effects in participation but no cohort effects. The baseline model controls for all state-specific factors that are constant over time and can affect outcomes via state fixed effects (α_s). This accounts for the possible correlation between the homestead exemption laws and unobserved state-level factors. Additionally, I account for differential state-specific linear time trends that capture unobserved state characteristics changing over time, $\alpha_{s,t}$. In the benchmark specification, I saturate the regressions with pairwise interacted fixed effects between state and household home equity, $\alpha_s \times \alpha_h$.[16] This allows comparing households from a given state with a similar level of home equity that

[15] I estimate an OLS model despite that the dependent variable is binary. The large number of fixed effects over several dimensions would give rise to an incidental parameter problem when using a nonlinear model, whereas the OLS coefficients are still consistent.

[16] α_h is defined for one-unit bins of the IHS of home equity, which singles out households with negative home equity and renters, rendering a maximum of 14 bins.

are below and above the exemption.[17]

Being below the state exemption is endogenous to stock market participation. In particular, omitted variables could drive both home equity and stock holdings. A household that experiences a negative wealth shock may reduce its home equity, by taking a home equity loan for instance, switching from being above to being below the state exemption. If it also exits from the stock market, $\hat{\alpha}_1$ will be negative for reasons unrelated to the bankruptcy protection. To address this possibility, I follow the instrumental variable (IV) strategy from Mahoney (2015), based on Currie and Gruber (1996). The instrument measures the generosity of the homestead exemption in a state and year towards different demographic groups. By controlling for state and demographic group fixed effects, this so-called "simulated instrument" exploits within-state variation in the protection given to the home equity of each group. Demographic groups that invest a higher fraction of their wealth in home equity are more likely to be below the exemption in states with a higher homestead exemption. Since the demographic groups are nationally representative, the variation resulting from idiosyncratic shocks to households of a given state is removed.

To construct the instrument, I divide the sample into groups on the basis of all possible combinations of predefined categories for age, race, education, and family structure.[18] I compute the average home equity across all states for each demographic group in every year, excluding the own value of household i. Then I create a dummy that takes the value of 1 if the exemption level is above the group home equity for state s in year t, and of 0 otherwise. A simpler strategy would have been to only use the exemption level as an instrument. Considering that the IV estimator renders the treatment effect for the compliers, an advantage of using the simulated instrument is that the compliers are more representative of the average person in the population.[19] For example, a 16-35 years old, minority household, with no college education, and married with children is likely to be below the exemption generally. When the exemption is low, such household will be a complier to the simulated instrument, but not to the exemption level instrument.

[17] I do not include individual-level fixed effects because only 21% of the households in the sample change status from below to above the exemption or vice versa and, moreover, the response in terms of stock holdings may not be immediate.

[18] Similar to Mahoney (2015), the categories for age are 16-35, 36-45, 46-55 and 56-65 years old; for race are white and non-white; for educational attainment are less than college, some college and college completed; and for family structure are single and childless, married and childless, single with children, and married with children.

[19] In the simulated instrument, the compliers are households below the exemption if the home equity of their demographic group is below the exemption and above the exemption if the group home equity is above. Using the exemption level as the instrument, the compliers will be households below the exemption if the exemption is high, and above the exemption if it is low.

Since the endogenous explanatory variable is binary, it is possible to use the two-step instrumental variable (IV) method (see Wooldridge, 2010). Thus, I first estimate a probit model for the $Below_{ist-1}$ dummy on the simulated instrument, the time-varying controls (X_{ist} and R_{st}), and state and year fixed effects. Households living in states with unlimited exemptions are dropped because they are perfect predictors of being below the exemption. Then I estimate an ordinary two-stage IV regression of equation (8) using the predicted values of the probit model as an instrument for $Below_{ist-1}$. This approach improves the efficiency and precision of the two-stage least square (2SLS) estimator and does not require the probit model to be correctly specified for consistency.

5.1.2 Results

Table 4 shows the OLS estimates of equation (8) and the IV estimates using the simulated instrument. I restrict the sample to that used for the IV models that drops states with unlimited homestead exemption.[20] When controlling for state and year fixed effects and for state-specific linear time trends, the OLS model shows that participation is not significantly different when the home equity is below the exemption than when it is above (column 1). The 2SLS result is presented in column 2, where the exclusion restriction is given by the fitted values of the first-stage probit for the $Below_{ist-1}$ dummy on the simulated instrument, all the observable controls, state and year fixed effects, and state time trends. In the (unreported) first-stage estimate, the coefficient on the simulated instrument equals 0.326 and is significant at the 1% level. On the basis of the large F-statistic in column 2, the predicted probability of being below the exemption is strongly related to the actual probability. The second stage result shows a negative coefficient on the $Below_{ist-1}$ dummy (significant at the 1% level), which suggests that omitted variables bias the OLS estimate upward. This bias could reflect unobserved household factors, such as risk aversion or the preference for financial over real wealth, that are negatively correlated with the decision to accumulate home equity and positively correlated with the decision to participate in the stock market.

The remaining columns add state×home equity fixed effects to identify more precisely the effect of having the home fully protected—they control more comprehensively for unobserved, time-invariant drivers of participation at the state and home equity levels. In column 3, the OLS coefficient becomes negative and statistically significant at the 1% level. The IV estimate in column 4 becomes only slightly larger than in column 2. Finally, columns 5 and

[20] The OLS results remain similar when estimated in the full sample.

Table 4: Stock market participation when home equity is below the exemption

Dependent variables:	Own stocks						ΔOwn stocks	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Below exemption$_{t-1}$	.003	-.081***	-.017***	-.111***	-.014**	-.090***		
	(.008)	(.019)	(.006)	(.024)	(.006)	(.023)		
ΔBelow exemption$_{t-1}$							-.007	.101***
							(.008)	(.026)
Mean dependent variable	.176	.176	.176	.176	.176	.176	-.014	-.014
Household- and state-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	–	–	–	–	–	–
State time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State × home equity FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Demographic group FE	No	No	No	No	Yes	Yes	Yes	Yes
Kleibergen-Paap rk Wald F statistic		39.5		34.9		34.4		82.2
Observations	28,554	28,554	28,554	28,554	28,554	28,554	20,259	20,259

Notes. The dependent variable is a dummy variable that equals 1 if the household owns stocks in year t and 0 otherwise (columns 1 to 6) and its difference between t and $t-1$ (columns 7 and 8). "Below exemption" is a dummy variable that equals 1 if the household has home equity below the homestead plus wildcard exemption in $t-1$ and 0 otherwise. "ΔBelow exemption" is the difference in the "Below exemption" dummy between $t-1$ and $t-2$. Household-level controls include restricted cubic splines of the IHS of household wealth and labor income, dummies for the head's marital status and college education and the logarithm of age and family size. State-level controls include proprietor employment and state house prices deflated by the CPI. Home equity FE are defined for one-unit bins of the IHS of home equity. Demographic group FE are defined for the combination of categories for age, race, educational attainment, and family structure. All variables are described in Appendix Table A.1. The odd columns show the results of the OLS estimates of equation (8) and the even columns show the results of the 2SLS estimation where the "Below exemption" dummy (or its first difference) is instrumented with the predicted probability that the household is below the exemption (or its first difference), estimated from a probit model. States with unlimited exemptions are dropped from the sample. The household data are from the PSID for the period 1999-2011. Robust standard errors clustered at the state level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

6 show the preferred specification that adds fixed effects for demographic groups. Both the OLS and IV estimates decline slightly (in absolute value) relative to the previous specification. From column 6, when the home equity is below the exemption participation declines by 9 p.p. relative to when it is above. This is a large change of 51.1% relative to the sample mean of the dependent variable (17.6%).

It is possible, though, that unobserved heterogeneity at the household level persists even in the more saturated specification. To address such concern, in the last two columns I estimate the model for the first difference of stock ownership between t and $t-1$ on the first difference of the $Below_{ist-1}$ dummy between $t-1$ and $t-2$ and the full set of controls and fixed effects. The first-stage regression is the same as before, but the instrument is given by the first difference of the predicted values. This model tests whether, after a household switches to below the exemption, it is less likely to enter into the stock market or more likely to exit. The OLS estimate shows a negative but insignificant coefficient, whereas the IV coefficient becomes positive and significant. This result is not consistent with a substitution effect arising after the home becomes fully protected in bankruptcy.

Hypothesis 1 also predicts that the effect on participation should be increasing in the probability of bankruptcy. Thus, I estimate heterogeneous effects for households more likely to file for bankruptcy. I consider entrepreneurs, with higher income risk than wage workers. Further, if discharging mostly business debt, the self-employed are automatically eligible for Chapter 7 after the 2005 reform (i.e., they are not required to pass the means test). I also consider households in bad health that have higher exposure to medical expense risk than those in good health. The importance of medical costs in the household bankruptcy decision is documented by Himmelstein et al. (2005) and Gross and Notowidigdo (2011) and was acknowledged by the law through the Medical Bankruptcy Fairness Act of 2009. In addition, I consider households aged between 35 and 49 years old that are overrepresented in the population of bankruptcy filers relative to their share in the overall US population (Fisher, 2019).

In Table 5 I re-estimate the IV specification from column 6 of Table 4 using both sample splits and interaction terms. Since exemptions can also affect entrepreneurship entry or exit, I define self-employment on the basis of the status reported in the first wave that the household is in the sample. When splitting the sample, the effect of interest is only larger for the self-employed relative to wage workers (it is 163% larger). The estimated effect is actually smaller for households in bad than in good health and it is virtually the same for middle-aged relative to younger and older households. The last column shows the IV model estimated in the entire sample, including the interaction between the $Below_{ist-1}$ indicator and dummies for each of

Table 5: Stock market participation when home equity is below the exemption: Heterogeneous effects

					Age		
	Self-employed	Wage worker	Bad health	Good health	35-49	< 35 or > 49	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Below exemption$_{t-1}$	-.213**	-.081***	-.061***	-.094***	-.093***	-.098***	-.109***
	(.088)	(.023)	(.018)	(.027)	(.024)	(.034)	(.029)
Self-employed							-.012
× Below exemption$_{t-1}$							(.027)
Bad health							.042**
× Below exemption$_{t-1}$							(.019)
Age 35-49 yrs							.020
× Below exemption$_{t-1}$							(.018)
Mean dependent variable	.310	.162	.072	.193	.171	.179	.176
Hhld.- and state-level contr.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State × home equity FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic group FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
K-P rk Wald F stat.	11.1	37.4	148.2	27.9	130.2	19.0	7.2
Observations	2,617	25,868	4,028	24,397	11,525	16,935	28,455

Notes. The dependent variable, the "Below exemption" dummy, the household- and state-level controls and the fixed effects (as indicated) are the same as in Table 4. "Self-employed" is a dummy taking value 1 if the head is self-employed in the first year that joins the sample and 0 if is a wage worker. "Bad health" is a dummy taking value 1 when the head reports being in bad health and 0 if reports being in good health. "Age

35-49 yrs" is a dummy taking value 1 if the head's age is between 35 and 49 years old and 0 otherwise. The sample is split according to self-employment status (columns 1 and 2), health status (columns 3 and 4), and the age dummy (columns 5 and 6). The results in column 7 are estimated for the entire sample and include the interaction dummies as standalone terms. All variables are described in Appendix Table A.1. All results correspond to the 2SLS estimation of equation (8) where the "Below exemption" dummy is instrumented with the predicted probability that the household is below the exemption. That probability is estimated from a probit model of the "Below exemption" dummy on the simulated instrument, and for column 7 the instrument is interacted with each of the dummies that measure the heterogeneous effects. States with unlimited exemptions are dropped from the sample. The household data are from the PSID for the period 1999-2011. Robust standard errors clustered at the state level are reported in parentheses. $p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

the three groups. The interaction with self-employment status is negative, as expected, but insignificant. For the other two groups it is positive (for households in bad health it is even statistically significant). In unreported results, I do not find evidence of stronger negative effects among households with a high ratio of non-mortgage debt to income relative to those less indebted. Therefore, I conclude that these results do not provide strong support to Hypothesis 1, even if a large effect is estimated for the entire sample. Generally, no stronger response is estimated from groups more likely to file for bankruptcy—only from the self-employed there is weak evidence of a stronger response.

5.2. Stock market participation and the exemption level

5.2.1 Empirical strategy

The second hypothesis states that a marginal increase in exemptions should reduce stock market participation when the exemption level is higher than the home equity but lower than the wealth level. In other words, the effect should be observed for rich households with a small fraction of their assets invested in home equity. Only 3.2% of the observations in the sample meet this requirement. Thus, marginal changes in the exemption are likely to have a limited impact on participation.

The negative marginal effect is expected at intermediate exemption levels. No impact is expected at low exemptions, where few households would have their homes fully protected, or at high exemptions, where the wealth level is likely to be lower than the exemption. Thus, I use a flexible transformation to capture this nonlinearity—linear fixed effect estimates may be misleading when the underlying relationship is nonlinear (Loken et al., 2012). In particular, I use a restricted cubic spline transformation that subdivides the range of values of the exemption using a set of knots (data points). It fits a separate regression line between the knots using cubic functions and joins these lines smoothly at the knots. I use four knots, which provides a good compromise between flexibility and parsimony.[21] Since there is not a basis for the knots' placement a priori, I place them at equally spaced percentiles of the log exemption distribution.[22] In my preferred specification, I restrict the sample to households with wealth higher than the exemption during the sample period. In that subsample, the effect should be observed at the top half of the exemption distribution—observations with high exemption, where no effect is expected, are already dropped.[23]

Thus, I estimate the following model to test the second hypothesis:

$$S_{ist} = \beta_0 + \beta_1 \log \overline{H}_{st} + \beta_2 \log \overline{H}_{st}^{'} + \beta_3 \log \overline{H}_{st}^{''} + \beta_4 X_{ist} + \beta_5 R_{st} + \beta_t + \beta_{s,t} + \beta_s \times \beta_h + \varepsilon_{ist} \quad (9)$$

where S_{ist}, X_{ist}, and R_{st} are the same as in equation (8). $\log \overline{H}_{st}$ is the linear variable and $\log \overline{H}_{st}^{'}$ and $\log \overline{H}_{st}^{''}$ are the two piecewise cubic variables created to estimate a four-knot restricted cubic spline for the logarithm of the exemption from state s in year t. $\overline{H}_{st}$ equals the sum of homestead and wildcard exemptions, deflated using the state-level house price index. To test for the linearity of the exemption effect, the null hypothesis is that the coefficients of the nonlinear terms are 0, that is, $\beta_2 = \beta_3 = 0$.

Equation (9) controls for year and state fixed effects, β_t and β_s, exploiting the substantial increases in the exemptions of some states, especially in the most recent years (see Figure 1 and Table 1), for identification. This addresses the potential correlation of fixed unobserved state characteristics with the exemption level and with stock holdings. The benchmark specification includes state-specific linear time trends, $\beta_{s,t}$, and state×home equity fixed effects, $\beta_s \times \beta_h$. Comparing households with similar home equity from the same state is especially appropriate in this setting, given that homes are protected at different exemption levels in different states.[24] Finally, ε_{ist} in equation (9) denotes the error term.

The identifying assumption behind the empirical strategy is that the timing of the changes in exemptions is orthogonal to the determinants of the demand for risky assets. Under this assumption, changes in exemptions should be an exogenous shock to households' demand

[21]Harrell (2001) notes that usually the number of knots is four, for large samples the preferred number is five and for small samples is three.

[22]If I created a categorical variable for low, middle and high exemption levels, identification would reflect exemption changes across categories, but the effect will be flat within categories. Hypothesis 2 instead predicts a smooth relationship between the exemption and participation. In turn, polynomial transformations produce a smooth fit but are not very flexible and do not behave well at the tails. The restricted splines used here constraint the functions to be linear before the first knot and after the last knot to avoid poor behavior in the tails.

[23]Further restricting the observations to those with home equity fully protected would introduce a sample bias, since the home equity is potentially affected by the exemption.

[24]Fixed effects for demographic groups are not included in equation (9). They are introduced to estimate the IV model using the simulated instrument, which is built at the demographic-group level.

for risky assets. It can be threatened if their determinants are also driving stock market participation. According to Cerqueiro and Penas (2016), the level of protection was typically changed to keep up with increasing home prices and rising medical costs. Another reason was the purpose to match higher exemptions in neighboring states that attracted "deadbeat" filers, who would transfer their exemptible assets. The lobbyists for higher exemptions are typically attorneys and law firms, who benefit from debt-related litigation, whereas banks and collectors lobby against debtor protection. As also shown by Cerqueiro and Penas (2016) and Severino and Brown (2017), I verify that the most likely sources of contemporaneous shocks are not significantly related to the exemption level and, therefore, changes in exemptions can be taken as plausibly exogenous.

5.2.2 Results

Table 6 shows the results of estimating equation (9), and the coefficients reported correspond to the restricted cubic spline transformation: log(Exemptions) is a linear term in the logarithm of the exemption, whereas log(Exemptions') and log(Exemptions") capture nonlinearities at intermediate and high exemption levels, respectively. In the full sample (columns 1 and 2), the coefficient on the linear term is positive, rather than negative, and statistically significant. Only in column 1, which excludes state×home equity fixed effects, the F-statistic allows rejecting the null hypothesis that the two nonlinear coefficients are jointly 0. As with most nonlinear transformations, the interpretation of the individual coefficients of the restricted cubic splines is not straightforward. Thus, I replicate these estimates using a piecewise linear spline transformation to ease the interpretation of the results. I use two knots, placed at values corresponding to the second and third knot of the restricted cubic spline. Appendix Table D.1 shows that the only significant effect is estimated at low exemptions and is positive.

When restricting the sample to households with wealth larger than the exemption in Table 6 (columns 3 and 4), the coefficients become larger in absolute value than those for the full sample and are statistically significant. The test of nonlinearity is passed at the 1% significance level, suggesting that the underlying relationship is nonlinear. Figure 3 plots how much the probability of participation changes for a unit change in log exemptions, along with the 90% confidence intervals, for each value of log exemptions. For the specification in column 4, it shows positive marginal effects at the bottom of the exemption distribution and negative effects at the middle. At the top of the distribution, where negative effects are expected (states with high exemptions are dropped), the confidence intervals include the 0. In the piecewise linear spline estimates of Table D.1, significant effects are estimated at low exemptions (i.e., below \$19,491) and at intermediate exemptions (i.e., between \$19,491 and \$40,374), taking a positive and negative sign, respectively. From column 4, following a one-standard-deviation increase in log exemptions, the decline in stock ownership at intermediate levels equals $-0.068 \times 0.873 = -0.059$ (5.9 p.p.). This change corresponds to a 14.8% decline relative to the mean ownership rate of 40%. These results suggest some substitution effect only at intermediate but not at high exemption levels.

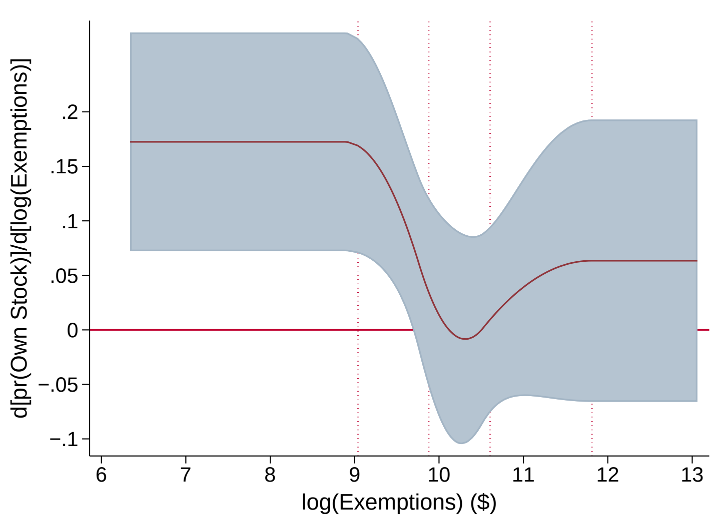
Table 6: Stock market participation and marginal changes in the exemption

Sample:	All the sample		Wealth > Exemption	
	(1)	(2)	(3)	(4)
log(Exemptions)	.027**	.022**	.112***	.119***
	(.011)	(.010)	(.036)	(.040)
log(Exemptions')	-.254**	-.227*	-.357***	-.394***
	(.124)	(.132)	(.090)	(.099)
log(Exemptions'')	.507*	.492	.986***	1.138***
	(.277)	(.303)	(.279)	(.299)
Mean dependent variable	.167	.167	.400	.400
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	–	Yes	–
State time trends	Yes	Yes	Yes	Yes
State × home equity FE	No	Yes	No	Yes
Test of nonlinearity	3.517**	1.664	7.883***	7.923***
R-Squared	.276	.292	.232	.256
Observations	46,454	46,454	9,555	9,555

Notes. The dependent variable, the household- and state-level controls, and the fixed effects (as indicated) are the same as in Table 4. "log(Exemptions)" is the linear term and "log(Exemptions')" and "log(Exemptions'')" are the two piecewise cubic variables created to estimate a four-knot restricted cubic splines for the logarithm of the homestead plus wildcard exemption level. All variables are described in Appendix Table A.1. I report the F-statistic corresponding to the "test of nonlinearity" of the null hypothesis log(Exemptions') = log(Exemptions'') = 0. In columns 3 and 4 the sample is restricted to households with wealth larger than the exemption level during the sample period. The household data are from the PSID for the period 1999-2011. Robust standard errors clustered at the state level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

Hypothesis 2 also predicts a stronger response from households more at risk of filing for bankruptcy. Thus, I estimate heterogeneous effects for the same groups considered when

Figure 3: Marginal effects of exemptions on stock market participation



Notes. The figure shows the marginal effects of exemptions on stock ownership estimated using the model in column 6 of Table 6. The marginal effects are plotted for various levels of the logarithm of homestead plus wildcard exemptions and are estimated at the means of the remaining covariates. The vertical dotted lines represent each of the four knots placed at equally spaced percentiles of the exemption's marginal distribution recommended by Harrell (2001). The sample is restricted to households with wealth larger than the exemption level during the sample period. The household data are from the PSID for the period 1999-2011. 90% confidence intervals are obtained by clustering the standard errors at the state level.

testing Hypothesis 1. Table 7 shows estimates using sample splits and the specification of column 4 in Table 6. For the self-employed and middle-aged households, the coefficients capturing nonlinearities at intermediate exemptions are more negative than for wage workers and for younger and older households, respectively. In contrast, for households in bad health the estimates are insignificant and, instead, are statistically significant for those in good health. Figure 4, similar to Figure 3, plots the marginal effects corresponding to these estimates. Only for the self-employed the marginal effects are negative and significant and only at intermediate exemption levels. In unreported results I interact the regressors of interest with the three group dummies and do not find significant differences across groups. These results generally do not suggest that households at higher risk of bankruptcy exhibit a stronger decline in participation.

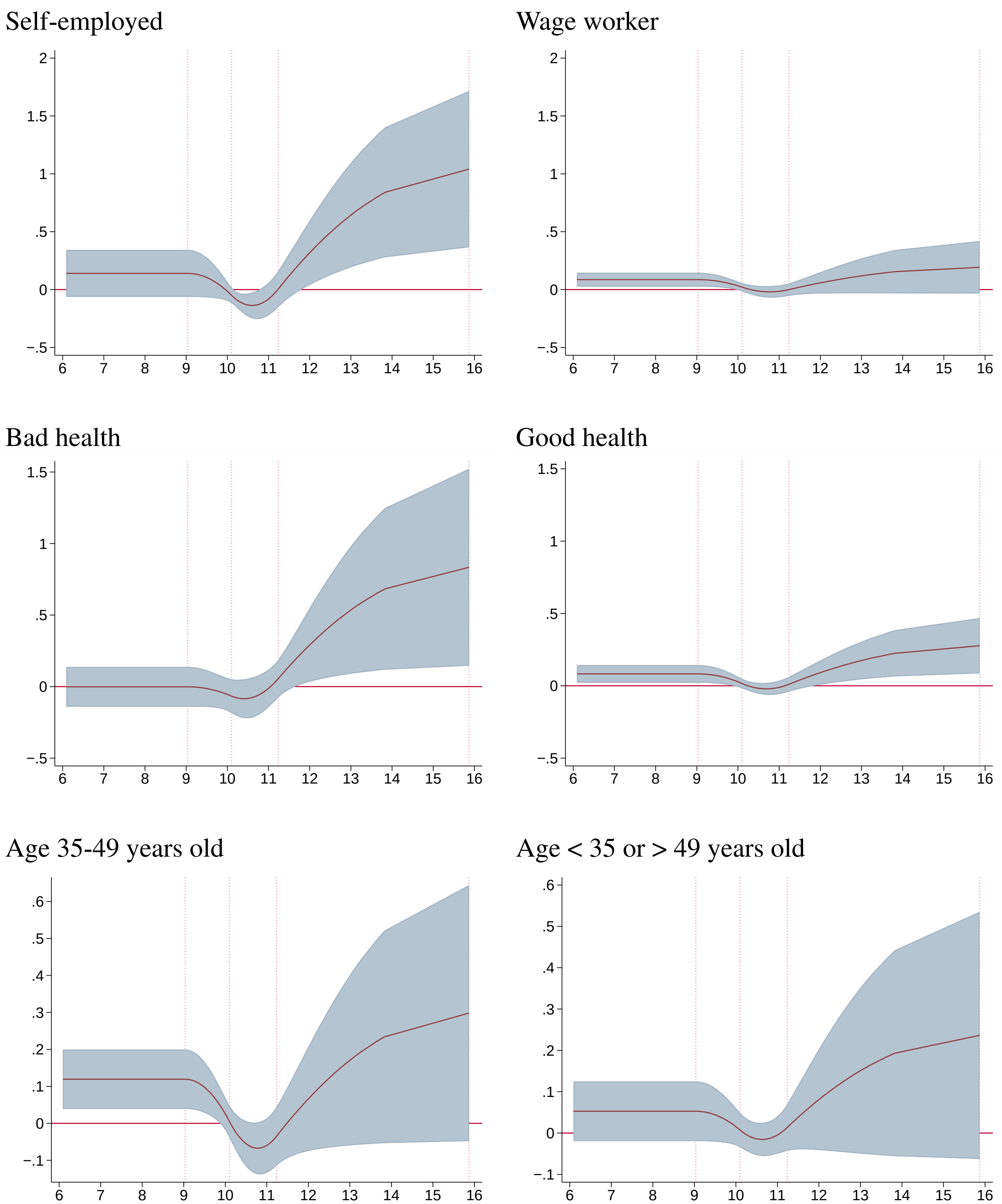
Finally, Table 8 explores the correlation between the logarithm of (homestead plus wildcard) exemptions and a set of state-level variables that may drive exemption changes. Not accounting for state fixed effects (column 1), I find that inflation-adjusted house prices are

Table 7: Stock market participation and marginal changes in the exemption: Households at higher risk of bankruptcy

Sample:	Wealth > Exemption					
					Age	
	Self-employed	Wage worker	Bad health	Good health	35-49	< 35 or > 49
	(1)	(2)	(3)	(4)	(5)	(6)
log(Exemptions)	.140	.086**	-.001	.082**	.119**	.053
	(.120)	(.036)	(.082)	(.036)	(.048)	(.043)
log(Exemptions')	-2.585*	-.885**	-.888	-.911**	-1.564**	-.623
	(1.398)	(.401)	(.893)	(.367)	(.591)	(.379)
log(Exemptions'')	8.066**	2.284**	4.018	2.550***	4.010**	1.865*
	(3.299)	(1.042)	(2.634)	(.888)	(1.497)	(1.033)
Mean dep. var.	.475	.386	.244	.414	.400	.400
Household- and state-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State time trends	Yes	Yes	Yes	Yes	Yes	Yes
State × home equity FE	Yes	Yes	Yes	Yes	Yes	Yes
Test of nonlinearity	4.414**	2.469*	2.201	4.549**	3.644**	1.630
R-Squared	.323	.268	.424	.250	.279	.275
Observations	1,502	7,999	737	8,758	3,705	5,781

Notes. The dependent variable, the household- and state-level controls, and the fixed effects (as indicated) are the same as in Table 4. The regressors of interest are the same as in Table 6. The sample is split according to self-employment status (columns 1 and 2), health status (columns 3 and 4), and the age dummy (columns 5 and 6), as defined in Table 5. All variables are described in Appendix Table A.1. I report the F-statistic corresponding to the "test of nonlinearity" of the null hypothesis log(Exemptions') = log(Exemptions'') = 0. The sample is restricted to households with wealth larger than the exemption level during the sample period. The household data are from the PSID for the period 1999-2011. Robust standard errors clustered at the state level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

Figure 4: Marginal effects of exemptions on stock market participation: Households at higher risk of bankruptcy



Notes. The figures show in the vertical axis the marginal effects of exemptions on stock ownership, estimated at the means of the remaining covariates using the models from Table 7. The horizontal axis shows the logarithm of homestead plus wildcard exemptions. The vertical dotted lines represent each of the four knots placed at equally spaced percentiles of the exemption's marginal distribution recommended by Harrell (2001). The sample is restricted to households with wealth larger than the exemption level during the sample period. The household data are from the PSID for the period 1999-2011. 90% confidence intervals are obtained by clustering the standard errors at the state level.

negatively related to the exemptions and the coefficient is significant at the 10% level. When adding state fixed effects (column 2), the coefficient on house prices becomes insignificant, whereas that for proprietor employment becomes significant at the 10% level. The latter turns insignificant, though, when including state-specific linear time trends. The results remain similar after adding medical expenses in column 4 (the sample size declines because of data availability). Nevertheless, I include home prices and proprietor employment among the controls when estimating the models for stock market participation. Further, dropping the full set of controls in column 5, I find that the R-squared remains almost the same as in column 4. This confirms that the variation in state-level regressors over time have little or no explanatory power to account for the variation in exemption levels. Thus, exemptions can be assumed as plausibly exogenous to changes in the demand for risky assets, as required for the identification of equation (9).

5.3. Holdings of stocks and home equity at the intensive margin

Hypothesis 3 predicts that, conditional on household's wealth, the holdings of stocks at the intensive margin will be lower when the home equity is fully protected. In this section I test that prediction and estimate equation (8) for the logarithm of the dollar amount invested in stocks, conditional on ownership, as the dependent variable. The results, reported in Table 9, are derived from the same benchmark specification as in Table 4 that includes fixed effects for state$\times$home equity and for demographic groups.

In the OLS model of column 1, the coefficient on the $Below_{ist-1}$ indicator is negative but insignificant. Column 2 reports the IV result using the approach described in section 5.1.1. Thus, I first estimate a probit model for the $Below_{ist-1}$ dummy on the simulated instrument, the household- and state-level controls, state and year fixed effects, and state time trends. The (unreported) estimate shows that the coefficient on the simulated instrument equals 0.326 and is significant at the 1% level. From the fitted values of this estimate I derive the predicted instrument. The F statistic reported in column 2 confirms a strong relation between the pre-

Table 8: Effects of state background variables on bankruptcy exemption levels

Dependent variable:	log(Exemption)				
	(1)	(2)	(3)	(4)	(5)
log(Inflation-adjusted house price)	-2.308*	.678	.310	.334	
	(1.345)	(1.005)	(.959)	(.903)	
log(Unemployment rate)	-1.079	.119	-.136	-.034	
	(1.160)	(.250)	(.225)	(.188)	
log(Proprietor employment)	.132	1.253*	-3.595	-2.774	
	(.362)	(.721)	(2.823)	(2.461)	
log(Per capita personal income)	-2.007	-.836	-.742	1.789	
	(2.732)	(.941)	(.864)	(2.688)	
log(Per capita state GDP)	.752	-1.551	-.402	-1.861	
	(2.422)	(1.170)	(.960)	(1.419)	
log(Non-business filings)	-1.238	.337	.102	.223	
	(.814)	(.414)	(.296)	(.364)	
Couples	.346***	.373***	.368***	.368***	
	(.060)	(.048)	(.050)	(.052)	
log(Per capita medical expenses)				-2.761	
				(3.239)	
Year FE	Yes	Yes	Yes	Yes	Yes
State FE	No	Yes	Yes	Yes	Yes
Mean dependent variable	11.418	11.418	11.418	11.348	11.348
Year FE	Yes	Yes	Yes	Yes	Yes
State FE	No	Yes	Yes	Yes	Yes
State time trends	No	No	Yes	Yes	Yes
R-Squared	.072	.950	.975	.976	.968
Observations	697	697	697	596	596

Notes. The dependent variable is the logarithm of homestead plus wildcard exemptions. Exemptions are deflated using the house price index at the state level from Freddie Mac. The sample period is 1999-2011, except in columns 4 and 5 where 2011 is excluded because medical expense data are not available. Only years surveyed in the PSID wealth questionnaires are included. All nominal values and the house price index are deflated with the Consumer Price Index (city level) from the BLS. Couples is a dummy taking value 1 for exemption levels corresponding to couples. All variables are described in Appendix Table A.1. Robust standard errors clustered at the state level are reported in parentheses. $*p < 0.10$; $**p < 0.05$; $***p < 0.01$.

Table 9: The intensive margin of stocks and home equity when home equity is below the exemption

Dependent variable:	log(Stocks)				Δlog(Stocks)		IHS(Home equity)				ΔIHS(Home eq.)	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Below exemption$_{t-1}$	-.067	-.601**	-.194**	-.690*			-.058***	-.052***	-.063***	-.070***		
	(.064)	(.240)	(.078)	(.344)			(.008)	(.013)	(.012)	(.013)		
Self-employed			.254	.453*					.004	.044*		
× Below exemption$_{t-1}$			(.160)	(.250)					(.014)	(.026)		
Bad health			.222	-.059					.028	.043		
× Below exemption$_{t-1}$			(.221)	(.405)					(.018)	(.030)		
Age 35-49 yrs			.157	-.026					.001	.012		
× Below exemption$_{t-1}$			(.123)	(.289)					(.010)	(.011)		
ΔBelow exemption$_{t-1}$					-.061	2.229***					1.528***	4.425***
					(.113)	(.606)					(.152)	(.483)
Mean dependent variable	9.999	9.999	9.999	9.999	.063	.063	10.526	10.526	10.526	10.526	-.194	-.194
Hhld.- and state-level contr.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State × home equity FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic group FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
K-P rk Wald F stat.		15.9		3.2		5.5		105.2		25.8		144.0
Observations	4,892	4,892	4,892	4,892	2,491	2,491	16,993	16,993	16,993	16,993	11,742	11,742

Notes. The dependent variable is the logarithm of the dollar value invested in stocks conditional on participation (columns 1 to 4), its difference between t and $t-1$ (columns 5 and 6), the IHS of the dollar value invested in home equity conditional on home ownership (columns 7 to 10), and its difference between t and $t-1$ (columns 11 and 12). The "Below exemption" dummy and its difference between $t-1$ and $t-2$, the household- and state-level controls and the fixed effects (as indicated) are the same as in Table 4. "Self-employed", "Bad health", and "Age 35-49 yrs" are the same dummies defined in Table 5. The results in columns 3, 4, 9, and 10 include the interaction dummies as standalone terms. All variables are described in Appendix Table A.1. The odd columns show the results of the OLS estimates of equation (8) and the even columns show the results of the 2SLS estimation where the "Below exemption" dummy (or its first difference) is instrumented with the predicted probability that the household is below the exemption (or its first difference), estimated from a probit model. States with unlimited exemption are dropped from the sample. The household data are from the PSID for the period 1999-2011. Robust standard errors clustered at the state level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

dicted instrument and the $Below_{ist-1}$ indicator. The second-stage result shows that the $Below_{ist-1}$ coefficient is negative and significant at the 5% level, indicating that the OLS result is biased upwards also at the intensive margin. As in Table 4, I reestimate the model using the specification in first differences to examine the change in stock holdings after the home becomes fully protected. The OLS coefficient remains similar (column 5), but the IV estimate becomes positive and significant (column 6). The corresponding F statistic is, however, below conventional levels.

Hypothesis 3 also predicts that the decline in stock holdings when the home becomes fully protected should be more pronounced among households at higher risk of bankruptcy. Thus, I estimate heterogeneous effects on the model in levels for the same groups considered in Tables 5 and 7. Column 3 shows that the interaction coefficients in the OLS model are positive, rather than negative, but not precisely estimated.[25] In the IV model of column 4, the instrument is weak and the interactions with the bad health and middle-age dummies are negative but insignificant. Overall, these results provide no substantive evidence that households reduce their stock holdings at the intensive margin when their home is fully protected in bankruptcy.

The substitution effect on stock holdings will arise only if households increase their home equity to obtain additional protection in bankruptcy. Thus, the counterpart of Proposition 3 (and also of Proposition 1) is that the holdings of home equity should be larger when the home is fully protected. To test for this, I estimate equation (8) for the IHS transformation of the home equity level, conditional on ownership. In columns 7 and 8 I find that the OLS and IV estimates are negative, rather than positive, and significant. In columns 11 and 12 I

[25]At the intensive margin I prefer to use interaction terms because the sample size declines considerably using sample splits.

estimate the model in first differences and both coefficients become positive and significant at the 1% level. Finally, when testing for heterogeneous effects in the model in levels (columns 9 and 10), only for the self-employed I find a positive and marginally significant coefficient in the IV specification.

In summary, the models in levels and in first differences render different signs for the coefficients of interest. Moreover, larger, stronger effects are not observed among households more at risk of bankruptcy. Thus, the findings in this section do not provide evidence supporting the predictions at the intensive margin, not only for the holdings of stocks but also for those of home equity.

5.4. Additional tests

5.4.1 Effects before the reform in the bankruptcy law

The little evidence of a substitution effect could be attributed to some households not being eligible to file under Chapter 7. After the 2005 reform, high-income households have to file under Chapter 13, as explained in section 2. To examine whether this is a plausible mitigating factor, I reestimate the main equations restricting the sample to the pre-reform period, that is, from 1999 until 2005. The results are reported in Appendix Tables D.2 and D.3.

In columns 1 and 2, Table D.2 shows the IV estimates of equation (8) for the participation decision that tests for Hypothesis 1. I find that the estimated reduction in participation when the home equity is below the exemption becomes larger. Relative to the sample mean of the dependent variable, the pre-reform coefficient from column 1 is 23.9% ($[-.132+.090]/.176=-.239$) larger (in absolute value) than that estimated in the entire period (column 6, Table 4). However, the difference is not statistically significant.[26] The estimates for households at higher risk of bankruptcy (column 2) are similar to those in Table 5 (column 7), confirming the absence of heterogeneous effects. The last two columns of Table D.2 show the IV estimates for stock holdings at the intensive margin to test for Hypothesis 3. The coefficient on the $Below_{ist-1}$ indicator becomes insignificant in column 3, as its interactions with the group dummies in column 4.

In turn, Table D.3 shows the estimates of equation (9) to examine the effect of marginal increases in the exemption predicted by Hypothesis 2. The results are similar to those estimated for the entire period. An (unreported) plot of the marginal effects does not reveal a

[26]Corradin et al. (2016) perform a similar test for the change in home equity, comparing the baseline results with those for the pre-reform period, and find an even smaller differential of 3.7% ($[.258-.249]/.246=.037$), not significant either.

decline in participation at intermediate and high exemptions. In this case, the effect of looser eligibility rules before the reform may be partially counteracted by the smaller time-series variation in exemptions—the larger increases occurred after 2007. Nevertheless, the overall findings suggest that the absence of substitution effects on stock holdings cannot be attributed to fewer households being eligible to file under Chapter 7 after the reform.

5.4.2 Investment response to wealth changes

Corradin et al. (2016) examine whether marginal investment in housing out of wealth drops when the home equity reaches the exemption level. The counterpart of that prediction is that marginal investment in the unprotected asset should increase above the exemption level. In Appendix C I show that the same prediction can be derived from the model in section 3.1.[27] That hypothesis, while intuitively plausible, is difficult to identify empirically. The benchmark specification in Corradin et al. (2016) tests it by regressing the change in home equity on the interaction between the $Below_{ist-1}$ indicator and the change in household wealth. The main concern with this strategy is that wealth changes are endogenous to investment in housing and are correlated with the home equity level (and, hence, with the $Below_{ist-1}$ indicator), which renders biased estimates.

With that caveat, in Table D.4 I also estimate a model for the effect of wealth changes, where the dependent variables are the first differences of the IHS of home equity (columns 1 to 5) and of the logarithm of stocks (columns 6 to 10). Following Corradin et al. (2016), I restrict the sample to home owners, define the below dummy for year t rather than $t-1$, and cluster the standard errors at the less conservative household level. The OLS result in column 1 replicates their specification from column 3 of Table 3 that only controls for year and state fixed effects. It shows that the interaction between the $Below_{ist}$ dummy and the change in wealth is positive and significant at the 1% level. In column 2 I reestimate the model in column 1, including the household- and state-level controls, for the sample used for the IV approach in column 3. The IV strategy allows comparing how the results in Corradin et al. (2016) vary when accounting for the endogeneity of the $Below_{ist-1}$ indicator. I find that the reestimated OLS model renders a larger coefficient for the regressor of interest, which becomes substantially smaller in the IV model of column 3 and insignificant. Columns 4 and 5 estimate the same specification as in columns 2 and 3, but including interactions with

[27] The model setup is in fact very similar, with one difference being that in Corradin et al. (2016) the unprotected asset has a non-random return that dominates that from the protected asset (equivalent to the positive stock premium). This and other small differences do not substantially alter the main predictions.

the indicators for households more at risk of bankruptcy (using the groups selected for this paper). In the OLS model, all triple interaction terms are insignificant. In the IV model, only that for the middle-aged households is positive and marginally significant.

Next, in columns 6 to 10 I reestimate the same specifications for the change in stocks for the sample of home and stock owners. Column 6 shows evidence of a decline in the marginal investment in stocks when the home is fully protected. In column 7, the OLS estimate declines (in absolute value) when accounting for time-varying controls in the IV sample. The coefficient blows up when estimated using the simulated instrument and becomes significant at the 1% level. In addition, there is no robust evidence that the effects are significantly stronger for households at higher risk of bankruptcy. In the IV model of column 10 the instrument becomes weak according to the F-statistic.

Summarizing, my empirical strategy addresses at least two main problems from that in Corradin et al. (2016). First, using my time-invariant instrument, I find that the home equity bias becomes insignificant. Only for robustness they instrument the current exemption with its value in 1920 to obtain the $Below_{ist-1}$ indicator. Such strategy does not address the main source of omitted variable bias coming from the households' choice of home equity. Second, after redefining the groups at higher risk of bankruptcy, my results show little evidence of a stronger response from riskier households. Corradin et al. (2016) look at heterogeneous effects from households in bad health and aged 40 years old or younger. The latter are not the age group more at risk of bankruptcy, as documented by Fisher (2019). In addition, they do not establish whether differences across groups are statistically significant, since groups at lower risk of bankruptcy also exhibit a significant response. Finally, an important concern remains: The endogeneity introduced by interacting the $Below_{ist-1}$ indicator with the change in wealth. Households with home equity below the exemption are likely to be poorer, as shown in Table 3. Thus, conditional on owning a home, any increase in wealth will be most likely used to repay the mortgage. Only richer households, with home equity above the exemption and hence no outstanding mortgage, are likely to invest their additional wealth in unprotected risky assets. This casts doubts on the existing evidence of a portfolio bias towards home equity, driven by the bankruptcy protection.

5.4.3 Statistical power

Finally, I consider the possibility that the PSID data used here do not have statistical power to find significance in this context—in fact, the SIPP data used by Corradin et al. (2016) have a larger sample size. Thus, I perform a power calculation using the method proposed by

Burlig et al. (2020), which accounts for serial correlation in panel data. I do it by simulation in the PSID sample for a difference-in-difference regression model, assuming a minimum detectable effect for the $Below_{ist-1}$ indicator of -0.02 p.p. (i.e., a 10% of the sample mean of the dependent variable).[28] I include the same control variables as in Table 4 and fixed effects for state and year. The 500 simulations randomize at the household level, households are sampled with replacement, and I assume that between 10% to 30% of the households receive the treatment (i.e., change from above to below the exemption and vice versa). The number of pre- and post-treatment periods varies from 1 to 3, and standard errors are clustered at the state level.

Under these assumptions, the power of the models for stock ownership goes from 0.39 to 0.86. Considering that the usual benchmark for a properly designed experiment is 0.80, it is possible that at least some of my estimates are under-powered. This issue is more likely to arise when estimating heterogeneous effects for households more likely to file for bankruptcy. Under similar assumptions, the power is higher in the models for the IHS of home equity, where it goes from 0.98 to 1.00. Thus, it is striking that I find no substantial effects at least for home equity. This provides further evidence against the role of the bankruptcy exemptions as an important source of bias in portfolio decisions more in general.

6. Conclusions

Social programs provide large amounts of wealth insurance that can affect households' portfolio decisions. One example of these programs, the US bankruptcy law, provides asset-specific protection when households are hit by a negative shock. Corradin et al. (2016) find that the home equity protection under Chapter 7 leads to excessive exposure to real estate risk ex ante. This paper studies whether it also has a substitution effect on the demand for stocks, which are not protected in bankruptcy but have valuable attributes for portfolio composition.

I find that households are less likely to own stocks when their home equity is below than when it is above the exemption, but the evidence is not robust. In addition, I do not find a stronger response from households at higher risk of bankruptcy. Moreover, I find little evidence of a home equity bias, even when estimating a model similar to that in Corradin et al. (2016). It is possible that the sample size of the PSID does not offer the statistical

[28]Even though equation (8) is not the canonical difference-in-difference model, the estimator proposed by Burlig et al. (2020) captures better the panel structure of the data than other existing techniques for power calculation. In any case, the purpose of these calculations is to illustrate the potentially low power of the models for stock ownership, not to use them for experiment design.

power needed to identify the effect on stock holdings, but its statistical power is higher for home equity. No home equity bias attributed to bankruptcy protection in the first place will result in no substitution effect on stock holdings.

Unintended effects on households' portfolios can justify advocating for a low homestead exemption or a general rather than an asset-specific exemption. Even if not conclusively, my findings do not uncover substantial distortions arising from the bankruptcy provisions. It is possible that other, more widespread institutional arrangements—such as property taxes and mortgage interest deductions (see, e.g., Sommer and Sullivan, 2018)—induce overconsumption of housing, crowding-out the demand for risky financial assets. Finally, this paper is silent about the positive spillovers of introducing consumer bankruptcy protection on stock market participation. Guaranteeing a consumption floor has the potential to encourage participation. I leave this as a promising research question to be investigated in a cross-country setting.

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Do Bankrupty Protection Levels Affect Households' Demand for Stocks?

Appendices

Mariela Dal Borgo

Table A.1: Definitions of household and state variables

This table summarizes the main household and state variables used in the paper. Except where indicated, all variables are extracted from the Panel Study of Income Dynamics.

Variable	**Description**
Below / above exemption	Dummy variable equal to 1 if the home equity value is below / above the (homestead plus wildcard) state exemption in year *t* and to 0 otherwise.
Stock market participation	Dummy variable equal to 1 if the head or anyone in the family have any stocks in publicly held corporations, mutual funds, or investment trusts (excludes stocks in employer-based pensions or individual retirement accounts), and to 0 otherwise.
log(Stocks) ($)	Logarithm of the dollar value invested in stocks by households that participate in the stock market.
IHS(Home equity) ($)	IHS transformation of the dollar value of the households' home equity, conditional on ownership.
IHS(Wealth) ($)	IHS transformation of the dollar value of the household's wealth, net of debt value. Wealth comprises the home equity and the value of seven asset types: (i) farm or business, ii) money in checking or saving accounts, money market funds, certificates of deposit, government savings bonds and treasury bills, iii) any real estate other than the main home, iv) stocks, v) vehicles, vi) other savings or assets (bond funds, life insurance policy, a valuable collection for investment purposes, etc.) vii) money in private annuities or Individual Retirement Accounts. Other debts include credit card charges, student loans, medical or legal bills, or loans from relatives.

Variable	Description
IHS(Income) ($)	IHS transformation of the dollar value of the head's labor income, plus farm income and the labor portion of business income from unincorporated business, corresponding to the last calendar year.
log(Age of the head) (years)	Logarithm of the actual age of the head of the family unit.
College education	Dummy variable equal to 1 if the household head has some college education and to 0 otherwise.
Highest year of college completed	Highest year of college completed by the household head.
Married	Dummy variable equal to 1 if the head in the household is married or has a first-year cohabitor in the family unit and to 0 otherwise.
log(Family size)	Logarithm of family size that equals the number of adults and of persons under 18 years of age in the family unit, whether or not they are actually children of the head or wife, at the time of the interview.
Self-employed	Dummy variable equal to 1 if the head of the household is "self-employed only" (excludes those self-employed that also work for someone else) in the first year that is part of the sample and to 0 otherwise.
Bad health	Dummy variable equal to 1 if the head reports having fair or poor health and to 0 otherwise.
Age 35-49 yrs	Dummy variable equal to 1 if the head of the household is between 35 and 49 years old and to 0 otherwise.
log(Exemption) ($)	Logarithm of the dollar value of the homestead plus wildcard exemption under Chapter 7 . For states with unlimited homestead exemption, it is set to the maximum home equity value observed in the sample.

Variable	Description
Unlimited exemption	Dummy variable equal to 1 if the homestead exemption of state *s* in year *t* is unlimited and to 0 otherwise.
log(Inflation-adjusted house price)	Logarithm of the state-level house price index from Freddie Mac. The inflation-adjustment is done using the Consumer Price Index from the BLS (2004 = 100).
log(Unemployment rate)	Logarithm of the state-level unemployment rate from the BLS.
log(Proprietor employment)	Logarithm of the state-level estimates of nonfarm self-employment, consisting of the number of sole proprietorships and the number of individual business partners not assumed to be limited partners (BEA).
log(Per capita personal income) ($)	Logarithm of the total personal income divided by total midyear population (BEA). I deflate this measure by the CPI (2004 = 100).
log(State GDP) ($)	Logarithm of the real GDP by state in millions of chained 2009 dollars (BEA).
log(Non-business bankruptcy filings) (per 1,000 inhabitants)	Logarithm of the total number of non-business bankruptcy cases commenced (includes Chapters 7, 11 and 13) from the Statistics Division of the Administrative Office of the US Courts, divided by the total state population (in 1,000s).
log(Per capita medical expenses) ($)	Logarithm of the personal health care expenditures (CMS) divided by the total state population.

Appendix B. Proof of Propositions in Section 3.1

Proof of proposition 1. The household problem is:

$$\max_{\mathbb{1}(s^*>0)}\left\{\max_{s}\left[p(1-\varepsilon)\log\left(W-q+r_{high}s\right)+(1-p)(1-\varepsilon)\log\left(W-q-r_{low}s\right)+\right.\right.$$
$$\left.\left.+\varepsilon\log\left(\min\left(W-s-q,\overline{H}\right)\right)\right],\left[(1-\varepsilon)\log(W)+\varepsilon\log\left(\min\left(W,\overline{H}\right)\right)\right]\right\} \quad \text{(B.1)}$$

The envelope theorem shows that the derivative of the households' maximal utility conditional on participation with respect to q is given by:

$$\frac{\partial E[U(s^{**})]}{\partial q}=-\frac{p(1-\varepsilon)}{W-q+r_{high}s^{**}}-\frac{(1-p)(1-\varepsilon)}{W-q-r_{low}s^{**}}-\mathbb{1}(h^{**}<\overline{H})\frac{\varepsilon}{W-s^{**}-q}<0 \quad \text{(B.2)}$$

where $\mathbb{1}(\cdot)$ is an indicator function which is equal to 1 if the argument is true, and to 0 otherwise. The inequality holds because condition (4) is never binding and therefore the denominators of each of the terms are positive at the optimum.

Given that h^{**} can be above or below $\overline{H}$, there are two cases to consider:

i) Home not fully protected: $h^{**}\geq\overline{H}$

Since $\partial E[U(s^{**})]/\partial q$ is negative for $q\in(0,W)$, it must be that $E[U(s^{**})]>E[U(s=0)]$ as $q\to 0$ and $E[U(s^{**})]<E[U(s=0)]$ as $q\to W$. Given that $E[U(s^{**})]$ is continuous in q, there exists a $q^I_{h^{**}\geq\overline{H}}\in(0,W)$ such that $E[U(s^{**})]=E[U(s=0)]$. And since $E[U(s^{**})]$ is strictly decreasing in $q\in(0,W)$, that number $q^I_{h^{**}\geq\overline{H}}$ is unique for $h^{**}\geq\overline{H}$. When $q>q^I_{h^{**}\geq\overline{H}}$, the household does not invest in stocks, $s^*=0$, and allocates all its wealth to asset $h^*=W$. When $q<q^I_{h^{**}\geq\overline{H}}$, it invests some positive amount in stocks, $s^*>0$, and reduces the investment in asset $h^*<W$.

ii) Home fully protected: $h^{**}<\overline{H}$

The same reasoning as in part i) shows that there exists a unique $q^I_{h^{**}<\overline{H}}\in(0,W)$ such that $E[U(s^{**})]=E[U(s=0)]$ for $h^{**}<\overline{H}$. When $q>q^I_{h^{**}<\overline{H}}$, the household does not invest in stocks, $s^*=0$, and when $q<q^I_{h^{**}<\overline{H}}$, it invests some positive amount, $s^*>0$. Since $\partial E\left[U\left(s^{**}\right)\right]/\partial q$ is smaller when $h^{**}<\overline{H}$ than when $h^{**}\geq\overline{H}$ because of the negative term $-\varepsilon/(W-s^{**}-q)$ in the right-hand side of (B.2), $q^I_{h^{**}<\overline{H}}$ is smaller than $q^I_{h^{**}\geq\overline{H}}$. In addition, the first two terms in (B.2) are increasing in ε, whereas the third term, $-\varepsilon/(W-s^{**}-q)$, is decreasing in ε. This implies that the differential between $q^I_{h^{**}<\overline{H}}$ and $q^I_{h^{**}\geq\overline{H}}$ is increasing in ε. $\otimes$

Proof of proposition 2. Let's define a function $F\left(s^*,q,\overline{H},\varepsilon\right)$ equal to the difference in the expected utility for $s^*>0$ and in the expected utility for $s^*=0$, that is, $E[U(s^*>$

$0, q, \overline{H}, \varepsilon)] - E[U(s^* = 0, q, \overline{H}, \varepsilon)]$:

$$F\left(s^*, q, \overline{H}, \varepsilon\right) = p(1-\varepsilon)\log\left(W - q + r_{high}s\right) + (1-p)(1-\varepsilon)\log(W - q - r_{low}s) + \\ + \varepsilon\log\left(\min\left(W - s - q, \overline{H}\right)\right) - \left[(1-\varepsilon)\log(W) + \varepsilon\log\left(\min\left(W, \overline{H}\right)\right)\right] \quad \text{(B.3)}$$

$q^I_{h^{**}\geq\overline{H}}$ is the value that makes $F\left(s^*, q, \overline{H}, \varepsilon\right)$ equal to 0 when $h^{**} \geq \overline{H}$. The implicit function theorem gives the derivative of $q^I_{h^{**}\geq\overline{H}}$ with respect to $\overline{H}$:

$$\frac{\partial q^I_{h^{**}\geq\overline{H}}(\overline{H}, \varepsilon)}{\partial\overline{H}} = -\mathbb{1}(h^{**} \geq \overline{H})\frac{\partial F\left(s^*, q, \overline{H}, \varepsilon\right)/\partial\overline{H}}{\partial F\left(s^*, q, \overline{H}, \varepsilon\right)/\partial q} \quad \text{(B.4)}$$

Applying the envelope theorem to (B.3), I obtain the numerator of (B.4):

$$\mathbb{1}(h^{**} \geq \overline{H})\frac{\partial F\left(s^*, q, \overline{H}, \varepsilon\right)}{\partial\overline{H}} = \frac{\varepsilon}{\overline{H}} - \frac{\varepsilon}{\overline{H}} \quad \text{(B.5)}$$

The denominator in (B.4) is given by the expression in (B.2) for $h^{**} \geq \overline{H}$, and hence the derivative in (B.4) equals 0:

$$\frac{\partial q^I_{h^{**}\geq\overline{H}}(\overline{H}, \varepsilon)}{\partial\overline{H}} = \frac{\frac{\varepsilon}{\overline{H}} - \frac{\varepsilon}{\overline{H}}}{\frac{p(1-\varepsilon)}{W-q+r_{high}s^{**}} + \frac{(1-p)(1-\varepsilon)}{W-q-r_{low}s^{**}}} = 0 \quad \text{(B.6)}$$

$q^I_{h^{**}<\overline{H}}$ is the value that makes $F\left(s^*, q, \overline{H}, \varepsilon\right)$ equal to 0 when $h^{**} < \overline{H}$. The derivative of $q^I_{h^{**}<\overline{H}}$ with respect to $\overline{H}$ is given by:

$$\frac{\partial q^I_{h^{**}<\overline{H}}(\overline{H}, \varepsilon)}{\partial\overline{H}} = -\mathbb{1}(h^{**} < \overline{H})\frac{\partial F\left(s^*, q, \overline{H}, \varepsilon\right)/\partial\overline{H}}{\partial F\left(s^*, q, \overline{H}, \varepsilon\right)/\partial q} \quad \text{(B.7)}$$

Applying the envelope theorem to (B.3), I obtain the numerator of (B.7):

$$\mathbb{1}(h^{**} < \overline{H})\frac{\partial F\left(s^*, q, \overline{H}, \varepsilon\right)}{\partial\overline{H}} = -\mathbb{1}(W > \overline{H})\frac{\varepsilon}{\overline{H}} \quad \text{(B.8)}$$

The denominator in (B.8) is given by the expression in (B.2) for $h^{**} < \overline{H}$, and hence the derivative in (B.7) is:

$$\frac{\partial q^I_{h^{**}<\overline{H}}(\overline{H}, \varepsilon)}{\partial\overline{H}} = -\frac{\mathbb{1}(W > \overline{H})\frac{\varepsilon}{\overline{H}}}{\frac{p(1-\varepsilon)}{W-q+r_{high}s^{**}} + \frac{(1-p)(1-\varepsilon)}{W-q-r_{low}s^{**}} + \frac{\varepsilon}{W-s^{**}-q}} \leq 0 \quad \text{(B.9)}$$

which is negative when household's wealth is above the exemption and otherwise equals 0.

The derivative of (B.6) with respect to ε is 0 and the derivative of (B.9) with respect to ε is given by:

$$\frac{\partial^2 q^I_{h^{**}<\overline{H}}(\overline{H},\varepsilon)}{\partial\overline{H}\partial\varepsilon} = -\mathbb{1}(W \geq \overline{H}) \frac{\frac{p}{\left(W-q+r_{high}s^{**}\right)} + \frac{(1-p)}{(W-q-r_{low}s^{**})}}{\overline{H}\left[\frac{p(1-\varepsilon)}{W-q+r_{high}s^{**}} + \frac{(1-p)(1-\varepsilon)}{W-q-r_{low}s^{**}} + \frac{\varepsilon}{W-s^{**}-q}\right]^2} \leq 0 \qquad \text{(B.10)}$$

which also is negative when the exemption is lower than the household's wealth and is 0 otherwise. ⊗

Proof of proposition 3. Suppose $s^* > 0$, the analytical first-order conditions for stocks are as follows:

$$\frac{\partial E[U(s^{**})]}{\partial s} = \frac{p(1-\varepsilon)r_{high}}{W-q+r_{high}s^{**}} - \frac{(1-p)(1-\varepsilon)r_{low}}{W-q-r_{low}s^{**}} - \mathbb{1}(h^{**} < \overline{H})\frac{\varepsilon}{W-s^{**}-q} = 0 \quad \text{(B.11)}$$

There are two cases to consider depending on whether h^{**} is above or below $\overline{H}$:

i) Home not fully protected: $h^{**} \geq \overline{H}$

A closed-form expression for s^{**} can be derived from (B.11):

$$s^{**} = (W-q)\left(\frac{p}{r_{low}} - \frac{1-p}{r_{high}}\right) \qquad \text{(B.12)}$$

From the first-period budget constraint, the optimal choice of home equity is:

$$h^{**} = (W-q)\left(1 - \frac{p}{r_{low}} + \frac{1-p}{r_{high}}\right) \qquad \text{(B.13)}$$

If $q < W$ and if $pr_{high} - (1-p)r_{low} < r_{high}r_{low}$, the expression for h^{**} is positive. If the stock premium is greater than $r_{high}r_{low}$, investment in home equity will be negative. But $h^{**} < 0$ violates the nonnegativity condition in (5) and $h^{**} = 0$ does not satisfy $0 < \overline{H} \leq h^{**}$. Therefore, the solution will not be in the region where the home is not fully protected if the stock premium is greater than $r_{high}r_{low}$. The derivative of (B.12) with respect to ε is 0 because s^{**} does not depend on ε when $h^{**} \geq \overline{H}$.

ii) Home fully protected: $h^{**} < \overline{H}$

In this region there is no closed-form expression for s^{**}, which is implicitly defined by (B.11). Plugging the solution obtained for s in (B.12) into the first order conditions for

$h^{**} < \overline{H}$ from (B.11) gives:

$$\frac{-\varepsilon}{(W-q)\left(1+\frac{1-p}{r_{high}}-\frac{p}{r_{low}}\right)} < 0 \tag{B.14}$$

where the inequality holds if $q < W$ and if the stock premium is between 0 and $r_{high}r_{low}$, which are the conditions for a solution in region i). This means that, if the stock premium is smaller than $r_{high}r_{low}$, s^{**} in part ii) will be positive but smaller than in part i) and, from (2), h^{**} in part ii) will be larger than in part i). If the stock premium is greater than $r_{high}r_{low}$, then the optimal values for s and h will always be in region ii) where $h^{**} < \overline{H}$.

To obtain the derivative with respect to ε, I apply the implicit function theorem to (B.11):

$$\frac{\partial s(W,\varepsilon)}{\partial \varepsilon} = -\mathbb{1}(h^{**} < \overline{H})\frac{\partial E[U(s^{**})]/\partial s \partial \varepsilon}{\partial E[U(s^{**})]/\partial^2 s} \tag{B.15}$$

Applying the envelope theorem to (B.11) for $h^{**} < \overline{H}$, it is possible to obtain the numerator and denominator of (B.15):

$$\mathbb{1}(h^{**} < \overline{H})\frac{\partial E[U(s^{**})]}{\partial s \partial \varepsilon} = -\frac{p r_{high}}{W-q+r_{high}s^{**}} + \frac{(1-p)\, r_{low}}{W-q-r_{low}s^{**}} - \frac{1}{W-s^{**}-q} \tag{B.16}$$

$$\mathbb{1}(h^{**} < \overline{H})\frac{\partial E[U(s^{**})]}{\partial^2 s} = -\frac{p\,(1-\varepsilon)\, r_{high}^2}{\left(W-q+r_{high}s^{**}\right)^2} - \frac{(1-p)\,(1-\varepsilon)\, r_{low}^2}{\left(W-q-r_{low}s^{**}\right)^2} - \frac{\varepsilon}{\left(W-s^{**}-q\right)^2} \tag{B.17}$$

Hence, after replacing the first two terms in (B.16) by the expression in (B.11), the derivative in (B.15) is:

$$\frac{\partial s(W,\varepsilon)}{\partial \varepsilon} = \frac{-\frac{1}{1-\varepsilon}\frac{1}{W-s^{**}-q}}{\frac{p(1-\varepsilon)r_{high}^2}{\left(W-q+r_{high}s^{**}\right)^2} + \frac{(1-p)(1-\varepsilon)r_{low}^2}{\left(W-q-r_{low}s^{**}\right)^2} + \frac{\varepsilon}{\left(W-s^{**}-q\right)^2}} < 0 \tag{B.18}$$

Since the derivative is negative, an increase in ε reduces s^{**} when the home is fully protected. ⊗

Appendix C. Comparative Statics for Wealth Changes

This appendix uses the model in section 3.1 to show how marginal changes in wealth affect investment in stocks and in housing at the intensive margin, similar to the model in Corradin et al. (2016). Similar conclusions can be derived for the effect of wealth changes on the participation decision, that is, at the extensive margin. As before, two cases can be considered:

i) Low bankruptcy protection (home not fully protected): $h^{**} \geq \overline{H}$

From equation (B.12), the derivative of s^{**} with respect to W is:

$$\frac{ds^{**}}{dW} = \frac{p}{r_{low}} - \frac{1-p}{r_{high}} \tag{C.1}$$

which is positive whenever the stock premium is positive. From equation (B.13), the derivative of h^{**} with respect to W is:

$$\frac{dh^{**}}{dW} = 1 - \frac{p}{r_{low}} + \frac{1-p}{r_{high}} \tag{C.2}$$

which is positive whenever the stock premium is smaller than $r_{high}r_{low}$. The derivatives in (C.1) and (C.2) are inversely related since ${}^{dh^{**}}/_{dW} = 1 - {}^{ds^{**}}/_{dW}$.

ii) High bankruptcy protection (home fully protected): $h^{**} < \overline{H}$

Since there is no closed-form expression for s^{**}, I obtain the derivative with respect to W by applying the implicit function theorem to (B.11):

$$\frac{\partial s(W,\varepsilon)}{\partial W} = -\mathbb{1}(h^{**} < \overline{H}) \frac{\partial E[U(s^{**})]/\partial s \partial W}{\partial E[U(s^{**})]/\partial^2 s} \tag{C.3}$$

Applying the envelope theorem to (B.11), it is possible to obtain the numerator and denominator of (C.3):

$$\mathbb{1}(h^{**} < \overline{H}) \frac{\partial E[U(s^{**})]}{\partial s \partial W} = -\frac{p(1-\varepsilon)\, r_{high}}{\left(W - q + r_{high}s^{**}\right)^2} + \frac{(1-p)(1-\varepsilon)\, r_{low}}{\left(W - q - r_{low}s^{**}\right)^2} + \frac{\varepsilon}{\left(W - s^{**} - q\right)^2} \tag{C.4}$$

$$\mathbb{1}(h^{**} < \overline{H}) \frac{\partial E[U(s^{**})]}{\partial^2 s} = -\frac{p(1-\varepsilon)\, r_{high}^2}{\left(W - q + r_{high}s^{**}\right)^2} - \frac{(1-p)(1-\varepsilon)\, r_{low}^2}{\left(W - q - r_{low}s^{**}\right)^2} - \frac{\varepsilon}{\left(W - s^{**} - q\right)^2} \tag{C.5}$$

Hence, the derivative in (C.3) equals:

$$\frac{\partial s(W,\varepsilon)}{\partial W} = \frac{-\frac{p(1-\varepsilon)r_{high}}{\left(W-q+r_{high}s^{**}\right)^2} + \frac{(1-p)(1-\varepsilon)r_{low}}{(W-q-r_{low}s^{**})^2} + \frac{\varepsilon}{(W-s^{**}-q)^2}}{\frac{p(1-\varepsilon)r_{high}^2}{\left(W-q+r_{high}s^{**}\right)^2} + \frac{(1-p)(1-\varepsilon)r_{low}^2}{(W-q-r_{low}s^{**})^2} + \frac{\varepsilon}{(W-s^{**}-q)^2}} \tag{C.6}$$

Considering that ${}^{dh^{**}}/_{dW} = 1 - {}^{ds^{**}}/_{dW}$, the derivative for housing equals:

$$\frac{\partial h(W,\varepsilon)}{\partial W} = \frac{\frac{pr_{high}\left(r_{high}+1\right)}{\left(W-q+r_{high}s^{**}\right)^2} + \frac{(1-p)r_{low}(r_{low}-1)}{(W-q-r_{low}s^{**})^2}}{\frac{pr_{high}^2}{\left(W-q+r_{high}s^{**}\right)^2} + \frac{(1-p)r_{low}^2}{(W-q-r_{low}s^{**})^2} + \frac{\varepsilon}{(1-\varepsilon)(W-s^{**}-q)^2}} \tag{C.7}$$

Since there is no closed-form solution for s^{**} when $h^{**} < \overline{H}$, it is not possible to derive the ones for (C.6) or (C.7) either. Thus, in Appendix Table C.1, I use the numerical example

Table C.1: Numerical example: Effect of wealth changes

	$W = 50$	$W = 100$	$W = 150$	$W = 200$	$W = 250$	$W = 300$
r_{high}	1	1	1	1	1	1
r_{low}	1	1	1	1	1	1
p	0.75	0.75	0.75	0.75	0.75	0.75
H	100.0	100.0	100.0	100.0	100.0	100.0
q	10.0	10.0	10.0	10.0	10.0	10.0
ε	0.05	0.05	0.05	0.05	0.05	0.05
h^I	26.2	52.4	78.6	104.8	109.7	131.6
s^I	19.4	38.7	58.1	77.4	109.7	131.6
q^I	4.5	8.9	13.4	17.8	30.7	36.8
h^{**}	23.0	51.8	80.5	109.3	120.0	145.0
s^{**}	17.0	38.3	59.5	80.8	120.0	145.0

Notes. This table shows a numerical example for the results derived in this Appendix, using the theoretical model in section 3.1. Each column corresponds to a different wealth level, W. All parameters are defined in Table 2.

from Table 2 to show how the optimal asset allocation changes with wealth. I use the same parameterization with $\varepsilon = 0.05$. The only difference is that the exemption level is fixed at

$\overline{H} = 100$, and what varies is the wealth level.

Table C.1 shows that when the home is fully protected, the optimal level of stocks conditional on participation increases from $s^{**} = 17$ to $s^{**} = 38$ when wealth goes from $W = 50$ to $W = 100$. Relative to the wealth change, this represents a change of $(38-17)/(100-50) = 0.4$. When the home equity is above the exemption, the level of stocks goes from $s^{**} = 120$ to $s^{**} = 145$ as wealth increases from $W = 250$ to $W = 300$. Hence, the relative change is of $(145-120)/(300-250) = 0.5$. Thus, the wealth elasticity of the demand for stocks is lower when the home equity is below than when it is above the exemption. Conversely, it is straightforward to see that the wealth elasticity of housing is higher when the home equity is below than when it is above the exemption. This is the home equity bias tested by Corradin et al. (2016).

Table D.1: Stock market participation and marginal changes in the exemption: Piecewise linear splines

Sample:	All the sample		Wealth > Exemption	
	(1)	(2)	(3)	(4)
Low exemptions	.024**	.025**	.069**	.086**
	(.012)	(.011)	(.033)	(.034)
Middle exemptions	.004	-.008	-.058**	-.068***
	(.013)	(.013)	(.022)	(.021)
High exemptions	-.026	-.004	.043	.062
	(.022)	(.014)	(.040)	(.039)
Mean dependent variable	.167	.167	.400	.400
Household- and state-level controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	–	Yes	–
State time trends	Yes	Yes	Yes	Yes
State × home equity FE	No	Yes	No	Yes
R-Squared	.159	.215	.226	.252
Observations	46,454	46,454	9,555	9,555

Notes. The dependent variable, the household- and state-level controls and the fixed effects (as indicated) are the same as in Table 4. Low, middle and high exemptions are the variables created to estimate two-knot linear splines for the logarithm of the homestead plus wildcard exemption level. The knots are placed at log exemptions equal to $10.1 and $11.2 (columns 1 and 2) and to $9.9 and $10.6 (columns 3 and 4), corresponding to the second and third knots of the restricted cubic splines computed for each of the samples. All variables are described in Appendix Table A.1. In columns 3 and 4 the sample is restricted to households with wealth larger than the exemption level during the sample period. The household data are from the PSID for the period 1999-2011. Robust standard errors adjusted for clustering at the state level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table D.2: Stock holdings when home equity is below the exemption in the pre-reform period

Dependent variable:	Own stocks		log(Stocks)	
	(1)	(2)	(3)	(4)
Below exemption$_{t-1}$	-.132***	-.157***	-.562	-.549
	(.034)	(.037)	(.403)	(.470)
Self-employed × Below exemption$_{t-1}$		.021		.434
		(.030)		(.301)
Bad health × Below exemption$_{t-1}$		.034		.212
		(.023)		(.424)
Age 35-49 yrs × Below exemption$_{t-1}$		.025		-.216
		(.023)		(.310)
Mean dependent variable	.203	.204	9.975	9.975
Household- and state-level controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State time trends	Yes	Yes	Yes	Yes
State × home equity FE	Yes	Yes	Yes	Yes
Demographic group FE	Yes	Yes	Yes	Yes
Kleibergen-Paap rk Wald F statistic	211.5	54.5	329.1	71.4
Observations	13,212	13,149	2,601	2,601

Notes. Column 1 reestimates the model in column 6 of Table 4, column 2 reestimates the model in column 7 of Table 5, and columns 3 and 4 reestimate the models in columns 2 and 4 of Table 9 for the period 1999-2005. Robust standard errors clustered at the state level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

Table D.3: Stock market participation and marginal changes in the exemption in the pre-reform period

Sample:	All the sample		Wealth > Exemption	
	(1)	(2)	(3)	(4)
log(Exemptions)	.056***	.048***	.154***	.172***
	(.016)	(.013)	(.056)	(.060)
log(Exemptions')	-.411**	-.331**	-.385**	-.412**
	(.186)	(.152)	(.165)	(.187)
log(Exemptions'')	.810*	.656*	.896*	1.065*
	(.423)	(.353)	(.498)	(.555)
Mean dependent variable	.191	.191	.417	.417
Year FE	Yes	Yes	Yes	Yes
State FE	Yes	–	Yes	–
State time trends	Yes	Yes	Yes	Yes
State × home equity FE	No	Yes	No	Yes
Test of nonlinearity	5.135***	4.456**	3.704**	2.712*
R-Squared	.285	.302	.248	.276
Observations	24,447	24,447	5,758	5,758

Notes. This table reestimates the models in Table 6 for the period 1999-2005. Robust standard errors clustered at the state level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table D.4: Investment response to wealth changes when home equity is below the exemption

Dependent variable:	ΔIHS(Home equity)					Δlog(Stocks)				
	OLS		IV	OLS	IV	OLS		IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Below exemption$_t$ × ΔIHS(Wealth)	.133***	.169***	.094	.193***	.052	-.070**	-.054*	-.222***	-.096**	-.222***
	(.032)	(.033)	(.080)	(.045)	(.087)	(.030)	(.030)	(.059)	(.044)	(.061)
Below exemption$_t$ × Self-employed				.039	-.009				.069	.029
× ΔIHS(Wealth)				(.124)	(.099)				(.079)	(.070)
Below exemption$_t$ × Bad health				-.074	.021				-.126*	.028
× ΔIHS(Wealth)				(.086)	(.060)				(.075)	(.023)
Below exemption$_t$ × Age 35-49 yrs				-.041	.079*				.090*	-.003
× ΔIHS(Wealth)				(.065)	(.046)				(.048)	(.028)
ΔIHS(Wealth)	.285***	.285***	.333***	.222***	.335***	.096***	.093***	.227***	.132***	.224***
	(.028)	(.028)	(.060)	(.036)	(.061)	(.029)	(.027)	(.055)	(.041)	(.058)
Below exemption$_t$	-1.634***	-1.870***	-.567	-1.894***	-.570	-.031	.180**	.614	.149	.627
	(.096)	(.123)	(.641)	(.146)	(.643)	(.057)	(.074)	(.639)	(.096)	(.635)
Mean dependent variable	-.155	-.157	-.157	-.157	-.157	.072	.068	.068	.068	.068
Household- and state-level controls	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Year and state FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap rk Wald F statistic			118.8		47.5			16.9		6.8
Observations	18,326	15,281	15,281	15,281	15,281	3,968	3,411	3,411	3,411	3,411

Notes. The dependent variables are the first difference in the IHS of the dollar value invested in home equity, conditional on home ownership (columns 1 to 5) and in the logarithm of the dollar value invested in stocks, conditional on home and stock ownership (columns 6 to 10). The "Below exemption" dummy, the household- and state-level controls and the fixed effects (as indicated) are the same as in Table 4. ΔIHS(Wealth) is the first difference in the IHS of total wealth. "Self-employed", "Bad health" and "Age 35-49 yrs" are the same dummies defined in Table 5. The results in column 4, 5, 9, and 10 include the interaction dummies as standalone terms. All variables are described in Appendix Table A.1. Columns 3, 5, 8, and 10 show the results of the 2SLS estimation where the "Below exemption" dummy is instrumented with the predicted probability that the household is below the exemption, estimated from a probit model. The remaining columns show the results of the OLS estimates of equation (8). Except in columns 1 and 6, states with unlimited exemptions are dropped from the sample. The household data are from the PSID for the period 1999-2011. Robust standard errors clustered at the state level are reported in parentheses. $*p < 0.10$; $**p < 0.05$; $***p < 0.01$