Life Insurance Demand and Borrowing Constraints

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Abstract

In empirical macroeconomic research, the positive relationship between financial development and life insurance development was taken for granted without delving into the complexity of the issue. Financial development supports life insurers' supply by providing confidence in the financial system, more efficient payment systems and higher availability of financial instruments. However, financial development reduces households' needs to save by relaxation of borrowing constraints, indirectly affecting saving through life insurance. We contribute by providing a demand-driven explanation of the negative consequences of financial development on life insurance development. We find that more credit-constrained countries have higher life insurance penetration on average. The effect is especially pronounced within high-income countries. The role of borrowing constraints indirectly signifies the importance of embedded options in life insurance policies for consumers. This study integrates the knowledge from life insurance theory, life insurance lapse, policy loans demand and saving under liquidity constraints literatures and produces implications for researchers, policymakers and life insurers.

Keywords: Life insurance, borrowing constraints, financial development

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I. Introduction

Does financial development spur life insurance demand? The empirical literature takes a one-sided look at the issue and firmly substantiates the role of financial development in boosting life insurance demand (Outreville, 1996; Ward and Zurbruegg, 2002; Beck and Webb, 2003; Li et al., 2007).[1] Supply-led channels such as rising confidence in the financial sector, efficient payment systems and higher availability of financial assets are provided to explain the positive relationship. However, previous studies fail to account for demand-driven explanations due to the adoption of too aggregate proxies of financial development,[2] which capture different supply and demand effects.

On the other hand, research into the finance-growth nexus elucidates the variety of channels through which financial development affects economic growth: funneling savings to firms, improving capital allocation and affecting saving rate through the relaxation of borrowing constraints (Pagano, 1993). The role of borrowing constraints suggests a negative relationship between financial development and life insurance demand. Households deliver two simultaneous interdependent decisions: how much to save and consume and how to allocate the accumulated savings (Headen and Lee, 1974). Jappelli and Pagano (1994) argue that led by precautionary motives or the need to finance current consumption, households, limited in borrowing the desired amount, may increase their savings. Since life insurance could be perceived as a liquid saving instrument, the rise in savings may instigate channeling the funds through life insurance (Headen and Lee, 1974; Beck and Webb, 2003). Consequently, financial liberalization and the expansion of credit availability curb the saving rate (Bayoumi, 1993; Jappelli and Pagano, 1994; 1998; Loayza et al., 2000), and, possibly, life insurance demand. However, using too aggregate proxies of financial development may mask the proposed negative relationship, given the unbalanced nature of

[1] Yuan and Jiang (2015) is the only study that finds no significant relationship between financial development and life insurance demand.

[2] To proxy for the level of financial development, authors use the ratio of broad definition of money over gross domestic product (Outreville, 1996; Li et al., 2007), total claims of deposit money banks on domestic non-financial sectors as a share of GDP (Beck and Webb, 2003) and private credit from banks and other financial institutions over GDP (Ward and Zurbruegg, 2002).

credit market development in terms of less limited access to credit for firms than for households (Jappelli and Pagano, 1994).

Following the previous reasoning, the next question naturally arises: Why would borrowing constrained households take out life insurance? Generally, depending on the type, life insurance combines protection and saving (cash value policies) or provides only protection for a certain time period (term life). Cash value policies offer additional options to those insured to borrow against cash values or collect the cash value prematurely (surrender), which might be valuable for borrowing constrained households. For instance, policyholders may circumvent borrowing from banks by taking policy loans. In the past policy loans were mainly used for non-emergent needs such as supporting business, home improvements, paying off debts or purchasing a car (Wood, 1964). The precautionary motive is implied in the emergency fund hypothesis. Policyholders tend to surrender their life insurance policies in case of significant liquidity shocks (Outreville, 1990; Kuo et al., (2003); Fier and Liebenberg, 2013; Gemmo and Gotz, 2016). Finally, households may take out life insurance if they face major financial obligations (Lin and Grace, 2007) or anticipate increasing liquidity constraints[3] in case of wage-earner death. Finally, constrained households have higher future net wealth (due to less borrowing) compared to the unconstrained ones (Jappelli and Pagano, 1994) and the possibility to save for retirement by purchasing life annuities.

The purpose of this study is to investigate empirically whether the international differences in life insurance consumption are attributed to the different levels of borrowing constraints across countries. To the best of our knowledge, this is the first study that empirically examines the relationship between borrowing constraints and life insurance demand. At a household level, life insurance theory proposes that borrowing constraints depress life insurance holdings. Zeng et al. (2016) assume that an individual should allocate his/her current wealth to consumption and to life insurance to hedge income loss in case of death. If constraints bind, a constrained individual (his/her wealth cannot be negative) has lower levels of life insurance compared to the levels of an unconstrained individual. However, Zeng et al. (2016), as well as, the rest of life insurance theory consider mainly term life insurance in the individual's portfolio optimization model. Our study signifies the importance of the saving component of life insurance products as well as the embedded options included (i.e. surrender and policy loan options).

On the methodological side, we use two proxies to measure the variation of credit constraints across countries: average Loan-to-value ratio and household credit to GDP ratio. While the first one is free from

[3] We use borrowing and liquidity constraints interchangeably.

identification problem,[4] the latter suffers from endogeneity issues. We tackle the problem of omitted variable bias and endogeneity by employing two estimation strategies. Firstly, to control for omitted variables bias, we estimate the regressions including the first proxy by using fixed-effects and random-effects panel data methodologies. Secondly, to remove the endogeneity problem of household credit proxy we employ the dynamic panel GMM two-step system estimator as suggested by Roodman (2009). Additional robustness checks are performed to control for results sensitivity on the sample selection.

Our results show that the increase in borrowing constraints (decrease in LTV and household credit to GDP ratios) stimulates life insurance demand. The relationship stays significant after we control for other channels of financial development. Financial development affects, mostly positively, life insurance supply and demand through many channels. However, financial liberalization and relaxation of borrowing constraints directly curbs life insurance demand by decreasing the households' needs to save. The effect is especially pronounced when we limit the sample to the more highly developed countries, which contradicts the view that borrowing constraints are non-binding in developed countries (Loayza et al., 2000). The coefficients are robust to different model specifications, sample selections and time aggregating.

Besides the main contributions, this study provides valuable insights into four other areas of research. Firstly, since liquidity constraints lead life insurance demand then a precautionary motive might be an essential reason for buying life insurance. This has implications for the sensitivity of life insurance demand on interest rate movements. Wen (2010) claims that precautionary saving under borrowing constraints may cause income growth to motivate higher savings regardless of interest rates. This may explain the insignificant or positive impact of interest rates on life insurance consumption (Headen and Lee, 1974; Beenstock, 1986; Outreville, 1996; Beck and Webb, 2003). Secondly, the previous reasoning has ramifications on the literature that examines the drivers of lapsations in life insurance.[5] One prevailing hypothesis is that higher interest rates may drive lapses due to arbitrage reasons. However, higher interest rates may imply a tight credit market that may motivate termination of life insurance contracts in case of significant cyclical shocks. Obviously, including a new environmental variable that would capture this effect may contribute better to explaining the lapse rate movements at macro level. Thirdly, much of the research regarding the determinants of policy loans demand (i.e. Wood, 1964; Cummins, 1973)

[4] Jappelli and Pagano (1994) suggest that the maximum LTV ratio forces households willing to purchase a house to save, should they want to meet the down payment regardless of their ability to repay. The constraints should hold for the consumer credit market as well, otherwise households would be able to borrow to meet the down payment.
[5] Eling and Kochanski (2013) provide detailed literature review on the topic.

evolved before the 'saving under liquidity constraints' literature. Our results corroborate the alternative fund hypothesis of this stream of literature. According to the hypothesis, life insurance policyholders demand policy loans if other crediting options are not available to them. Finally, we update the significance of borrowing constraints for savings rates across countries even though we encapsulate periods with substantial increase in credit availability and life insurance affordability.[6] The results conform with the evidence that liquidity constraints are still binding in different regions in Europe (Le Blanc et al., 2015).

The paper is organized as follows: Section II exhibits the possible channels through which borrowing constraints may affect saving rates and life insurance demand; Section III elaborates the data sample characteristics and methodological setup; Section IV illustrates the results of the basic regressions together with robustness checks; the conclusion section wraps up the paper.

II. Borrowing constraints, saving and life insurance demand

The notion of borrowing constraints and their role on consumer behavior evolved as a challenge to the life cycle permanent income hypothesis. Under the assumption of perfect capital markets the consumer is constrained only by the expected lifetime income with rationally smooth consumption during his/her entire lifetime. If an imperfect capital market i.e. credit rationing (Stiglitz and Weiss, 1981) is allowed for, households unable to borrow would have a different consumption path from the one suggested by the permanent income hypothesis. Evidence of the existence of borrowing constrained households and the impact of constraints on household balance sheets is strong despite the difficulties in identifying unobservable constrained households using household data (Hayashi, 1985; Zeldes, 1989; Fissel and Jappelli, 1990, Jappelli 1990; Cox and Jappelli, 1993; Grant, 2007).

The significant impact of borrowing constraints on economy aggregates, especially saving rates, exemplifies the prevalence of constrained households across countries. Financial deregulation and the relaxation of borrowing constraints contribute substantially to the decline in saving rates across countries (Bayoumi, 1993; Bandiera et al., 2000, Loayza et al., 2000). The positive relationship between borrowing constraints and saving rates was theoretically formalized in Jappelli and Pagano (1994). They build a three-period overlapping-generations model in which the younger generation is assumed to be constrained in borrowing the desired amount to finance current consumption and they compare the saving rate under

[6] Jappelli and Pagano (1998) argue that borrowing constraints are more important in countries with underdeveloped credit and insurance markets.

unconstrained and constrained cases. The unconstrained economy allows the younger generation to finance their consumption up to their discounted lifetime income and, when middle-aged, to repay the loan and save for retirement. The constrained economy limits the borrowings to a fraction of their discounted lifetime income resulting in higher savings for both younger and middle-aged generations, constituting the aggregate net wealth of the economy. [7] A higher aggregate net wealth leads to higher capital level stock, which translates into a higher steady-state growth and saving rate in the next period. Thus, the existence of borrowing constraints stimulates savings and growth reinforces higher savings if the borrowing constraints are stricter. Two alternative processes may affect the constraints-savings link. Firstly, the direction of influence of borrowing constraints on saving rate could be reversed should the negative impact on human capital accumulation prevail over the positive one on consumption (De Gregorio, 1996).[8] Secondly, intergenerational transfers may alleviate the credit market imperfections and reduce the effect of borrowing constraints on saving rate and human capital accumulation (Cox and Jappelli, 1990; Guiso and Jappelli, 2002).

Principally, the extant literature postulates that underdeveloped credit and insurance markets should stimulate precautionary savings in households who secure themselves against various risks (Guiso et al., 1992; Jappelli and Pagano, 1998; Jappelli and Pistaferri, 2000), however it fails to account for the possible influence of credit markets on insurance, especially life insurance development. The multidimensionality of life insurance as a saving and risk-sharing instrument suggests potential interaction between credit availability and life insurance demand. Besides hedging human capital uncertainty, life insurance serves as a financial instrument through which households may channel their savings. The options to prematurely collect the saving component (cash-value) and borrow against it enable households to recoup in case of financial emergency after realization of unexpected risks. Thus, life insurance could be perceived as a package which may cover a wide spectrum of background risks. Moreover, there is evidence that life insurance was used to finance current consumption (Wood, 1964). Additionally, the possibility to circumvent borrowing from banks through policy loans suggests that life insurance might be preferred when facing tight credit markets. Finally, in unconstrained credit markets older households have lower

[7] The younger generation would consume less due to the constraints, while the middle-aged generation would repay less due to lower borrowings in the first period.

[8] De Gregorio (1996) claims that the total effect on the economy's saving rate is ambiguous due to the negative effects of borrowing constraints on human capital accumulation. The underlying assumption is that constrained households would prefer to work to sustain their consumption rather than to obtain education. Hence, the relaxation of borrowing constraints induces human capital accumulation, which translates into higher savings driven by the wealth effects on middle-aged households, who would tend to save for retirement.

ability to save for retirement due to their net wealth that is lower than the one they would have had, had they been constrained. Since relaxation of borrowing constraints may reduce the need for precautionary savings and ability to save for retirement, we propose a positive relationship between borrowing constraints and life insurance demand.

The vast majority of papers on life insurance demand theory depart from Yaari (1965), who introduces the problem of life insurance into an optimal consumption/investment decision-making framework assuming an uncertain lifetime. Most notable extensions to his work are Fischer (1973), who emphasizes that the loss of future income is the main motive behind purchasing life insurance, and Lewis (1989), who argues that beneficiaries' preferences and constraints should be considered in delivering optimal consumption/insurance solutions. While these works provide intuition about the drivers of life insurance demand, they are not appropriate to model aggregate life insurance demand because of two main reasons. Firstly, the theory considers mainly the risk component of life insurance policies (term insurance). Secondly, the absence of disaggregated data on life insurance premiums restricts the separation of risk- from saving-component factors, as well as supply from demand factors. Consequently, common practice in macroeconomic studies on life insurance demand is the integration of all possible factors which affect supply and demand of life insurance into a single model, specifying how each impacts saving, risk and annuity components and controlling for different econometric issues which may arise within such a setup (Ward and Zurbruegg, 2002; Beck and Webb, 2003; Li et al., 2007). We follow this approach and summarize the drivers of life insurance demand with their expected effects in Table 1.

III. Data and methodology

We collect annual data for a total of 55 countries over the period 1980-2017.The panel set is unbalanced due in particular to unavailable data for our main variables (Appendix). We measure life insurance demand using life insurance premiums as a percentage of Gross Domestic Product (GDP) extracting it from Swiss Re's web application *sigma-explorer*. To proxy for the level of borrowing constraints, we follow Jappelli and Pagano (1994) and use the average Loan-To-Value (LTV) ratio[9] collecting it from the integrated Macroprudential Policy (iMaPP) database constructed by Alam et al. (2019), available only for the period 2000-2016. The average LTV ratio indicates credit availability to households.[10] Households, regardless of

[9] The average LTV ratios are calculated as a simple average of all existing LTV limits on (mostly) housing loans, but also automobile loans and commercial real estate loans. If the LTV limit is absent, then the authors set 100 (Alam et al., 2019).

[10] The variability of borrowing constraints across countries and time is attributed to the regulation, cost of enforcing loan contracts and the level of information asymmetry (Jappelli and Pagano, 1994).

Table 1:Determinants of life insurance demand

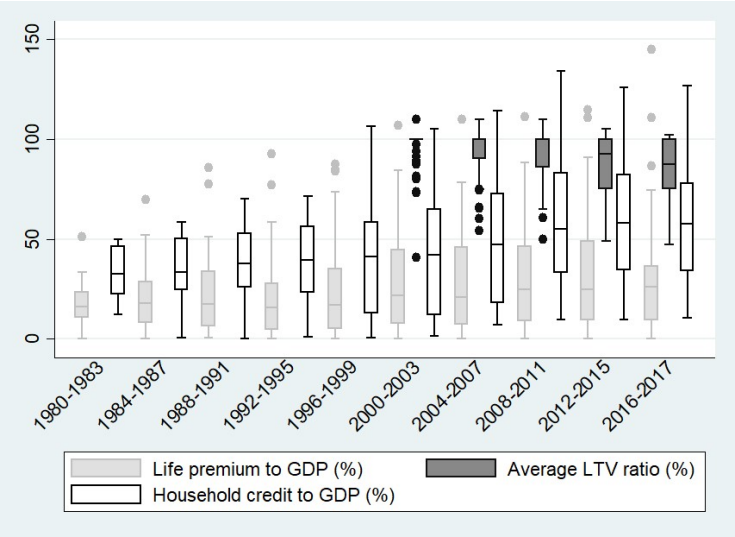
Basic model covariates			
Variable	**Proxies**	**Expected effect**	**Explanation**
Credit availability (relaxation of borrowing constraints)	Average LTV ratio; household credit to GDP	Negative	Higher credit availability reduces the need for precautionary or forced savings (Jappelli and Pagano, 1994) and negatively relates to the saving component of life insurance. Also, it decreases the net wealth of older households due to the previous borrowings, which negatively affects the saving for retirement.
Income	GDP per capita	Positive	Higher income enables affordability of various life insurance products. Additionally, high level of income presents potential big loss in case of wage earner death (Beenstock et al., 1986; Truett and Truett, 1990; Browne and Kim, 1993; Beck and Webb, 2003)
Education	Secondary school enrollment	Positive	Higher education extends the period of child dependency and increases the human capital of wage earner. Further, it serves as a proxy for risk aversion (Browne and Kim, 1993; Ward and Zurbruegg, 2002; Beck and Webb, 2003; Li et al., 2007). In our case, it also controls for the negative impact of borrowing constraints on human capital accumulation (De Gregorio, 1996).
Inflation	Consumer price index	Negative	Inflation erodes the value of life insurance policies. Additionally, price instability may reduce the supply of life insurance (Ward and Zurbruegg, 2002; Beck and Webb, 2003; Li et al., 2007).
Life expectancy	Life expectancy at birth	Ambiguous	Increasing life expectancy reduces the need for mortality coverage but stimulates accumulation of savings for retirement or demand for annuities (Beenstock et al., 1986; Beck and Webb, 2003). Also, life expectancy is a weak measure of life insurance price (Outreville, 1996; Ward and Zurbruegg, 2002).
Young dependency	Age dependency ratio (young)	Ambiguous	Higher number of young dependents positively affects mortality component of life insurance due to increasing need for protection in case of wage earner death, while negatively saving and annuity components due to higher percentage of population too young to save for retirement (Beck and Webb, 2003)
Old dependency	Age dependency ratio (old)	Ambiguous	Older population would tend to save for retirement, while it would be expensive for them to hedge the mortality risk by buying term-insurance (Beck and Webb, 2003)
Extended model covariates			
Financial development	Financial development index; non-household credit to GDP; Financial markets depth index	Positive	Financial development stimulates confidence in the financial sector, provides efficient payment systems and higher availability of financial assets (Outreville, 1996; Ward and Zurbruegg, 2002; Beck and Webb, 2003; Li et al., 2007).
Urbanization	Urban population	Positive	Greater concentration of population in urban areas cuts down the distribution channels costs and reduces the need for informal insurance agreements (Beck and Webb, 2003)
Women labor force participation	Labor force participation rate	Positive	Greater female labor participation supports life insurance demand due to women's improved earnings (Chen et al., 2001)
Social security	Social benefits to GDP	Negative	Social security benefits substitute for life insurance coverage. If government social programs are generous then households would demand less private hedge for mortality and longevity risks (Ward and Zurbruegg, 2002; Beck and Webb, 2003; Li et al., 2007)
Interest rate	Real interest rate	Ambiguous	Higher interest rates improve life insurers' profitability indirectly supporting supply of life insurance (Beck and Webb, 2003). Additionally, they may incentivize arbitrage behavior of households to allocate their wealth away from life insurance (Dar and Dodds, 1989). Finally, high interest rates may suggest tight credit.
Rule of law	Rule of law index	Positive	Better legal framework may provide healthy environment for life insurers to invest and price their products efficiently, as well as, it may reduce the opportunistic behavior of insurance companies which may result in greater demand for life insurance (Ward and Zurbruegg, 2002; Beck and Webb, 2003)

their ability to repay, must meet the down payment should they decide to obtain the loan. Moreover, if households are constrained on the housing credit market, they should also be so on the consumer credit market as well. We employ an alternative proxy of credit availability, the ratio of household credit to GDP, available for 42 countries over the period 1980-2017. Low values suggest that even though income level is higher, household credit is limited. The Appendix contains definitions and sources of all variables listed in the previous section.

We use non-overlapping 4-year averages[11] to perform the initial analysis and later check the stability of our results using annual data and an additional limited sample. Figure 1 shows the evolvement of our main variables over the period of analysis. Observing the medians of the boxplots, we note that the importance of life insurance for the economies is stable over time, although a slight increase and greater dispersion across countries appears during the 2000s. The LTV ratios show a decreasing trend reflecting the tightening of the credit market during the period 2000-2016. These trends conform to our claim that a stricter credit market would boost life insurance demand. However, we observe higher values of our household credit proxy after 2000 and a minor drop after 2008, which suggests the opposite relationship. The household credit measure captures some of the demand and supply factors, which also determine life insurance demand. Without multivariate regression analysis and correction for endogeneity, we are not able to capture the borrowing constraints effect from household credit proxy.

[11] Longer averages should smooth the effects of 2008 financial crisis and resolve the issue of lack of variation of the annual data of LTV ratios and Rule of Law proxy. The 4-years averaging limits the last period to one or two years (2016-2017).

Figure 1: Time and cross-country variation of life insurance penetration, average LTV ratio and household credit to GDP ratio



Note: Life premium to GDP (%) multiplied by 10

Sources: Swiss Re, Bank for International Settlements and Alam et al. (2019)

Table 2 summarizes descriptive statistics of the variables included in our analysis together with their correlations. The average GDP per capita is US25160 indicating a biased sample towards high-income countries, which also have high (rule of law) institutional development. Even within such a sample there is an immense variability in household credit to GDP ratio spanning from 0.1% (Turkey) to 134% (Denmark). We erase the observations with abnormal inflation and interest rates, keeping those within the range -50%/+50% (Loayza et al., 2000). The correlation matrix confirms what we discover in Figure 1. Life insurance demand has a positive correlation with household credit proxy and a weakly negative one with average LTV ratio, while it has the strongest connection with financial development measures. Compared to previous studies (i.e. Ward and Zurbruegg, 2002; Beck and Webb, 2003), in our sample we observe moderate positive correlation between life insurance penetration and GDP per capita, which may indicate that within high-income countries the demand is not driven primarily by income levels.

Table 2: Descriptive statistics and correlations

Variable	LIP	LTV	HC	FDI	NHC	FMD	GDP	LIFE	EDU	INF	YDEP	ODEP	URB	RATE	FLP	SOC	ROL	ENG	FRA	SCAN	GER
Obs	439	275	323	550	322	550	471	547	501	490	548	548	550	320	499	292	275	55	55	55	55
Mean	2.65	90.69	47.86	0.47	81.2	0.35	25.16	74.78	94.27	5.79	33.39	18.21	70.89	5.24	49.57	9.57	0.76	0.22	0.4	0.09	0.29
Std. Dev.	2.5	14.36	29.16	0.23	45.6	0.3	16.74	5.42	21.26	7.61	12.59	7.12	16.27	5.62	11.48	5.65	0.19	0.42	0.49	0.29	0.46
Min	0	40.63	0.1	0	14	0	0.38	52.77	28.43	-2.75	15.04	4.27	20.48	-10.7	14.49	0	0.17	0	0	0	0
Max	14.5	110	134	0.95	357	1	94.6	84.23	161	48.87	86.41	44.47	100	47.13	79.32	20.2	1	1	1	1	1
Correl.																					
LIP	1	-0.06	0.52	0.67	0.43	0.65	0.37	0.4	0.33	-0.35	-0.19	0.17	0.3	-0.17	0.13	0.19	0.32	0.24	-0.27	0.09	0.01
LTV		1	-0.09	-0.07	-0.25	-0.07	-0.01	-0.14	0.01	0.11	0.11	0.09	-0.11	0.02	-0.1	0.18	-0.03	0	0.18	-0.17	-0.09
HC			1	0.79	0.52	0.7	0.64	0.65	0.52	-0.49	-0.45	0.47	0.3	-0.25	0.52	0.03	0.61	0.2	-0.34	0.24	0
FDI				1	0.51	0.88	0.71	0.68	0.44	-0.5	-0.39	0.35	0.44	-0.15	0.2	0.22	0.54	0.22	-0.19	0.13	-0.09
NHC					1	0.48	0.67	0.58	0.38	-0.37	-0.41	0.36	0.28	-0.25	0.32	0.33	0.6	-0.09	-0.07	0.16	0.05
FMD						1	0.61	0.57	0.42	-0.45	-0.29	0.25	0.41	-0.18	0.24	0.14	0.48	0.33	-0.21	0.13	-0.16
GDP							1	0.73	0.6	-0.43	-0.5	0.59	0.53	-0.18	0.3	0.36	0.74	-0.01	-0.13	0.31	-0.04
LIFE								1	0.63	-0.47	-0.65	0.62	0.6	-0.13	0.26	0.4	0.64	-0.13	-0.05	0.22	0.04
EDU									1	-0.42	-0.63	0.63	0.6	-0.05	0.26	0.34	0.47	-0.09	-0.08	0.29	-0.03
INF										1	0.36	-0.29	-0.24	0.04	-0.19	-0.15	-0.32	-0.13	0.22	-0.07	-0.07
YDEP											1	-0.76	-0.31	0.18	-0.34	-0.52	-0.35	0.3	0.1	-0.1	-0.32
ODEP												1	0.29	-0.2	0.28	0.59	0.44	-0.34	-0.04	0.24	0.2
URB													1	0.03	0.05	0.19	0.39	-0.07	0.05	0.25	-0.15
RATE														1	0.02	0.02	-0.29	-0.09	0.16	0.01	-0.09
FLP															1	-0.31	0.29	-0.01	-0.32	0.41	0.09
SOC																1	0.27	-0.46	0.19	-0.14	0.22
ROL																	1	0.07	-0.31	0.4	0.02
ENG																		1	-0.43	-0.17	-0.34
FRA																			1	-0.26	-0.52
SCAN																				1	-0.2
GER																					1

Notes: Data averaged over 4-year non-overlapping periods; LIP – Life insurance penetration (%); LTV – Average LTV ratio (%); HC – Household credit to GDP (%); FDI – Financial development index; NHC – Non-household credit to GDP (%); FMD – Financial market depth index; GDP – GDP per capita (scaled by 1000); LIFE – Life expectancy; EDU – Secondary enrollment ratio; INF – Consumer price index; YDEP – Young dependency ratio; ODEP – Old dependency ratio; URB – Urban population (%); RATE – Real interest rate (%); FLP – Female labor participation; SOC – Social benefits to GDP (%); ROL – Rule of law index; ENG – English legal origin dummy; FRA – French legal origin dummy; SCAN – Scandinavian legal origin dummy; GER – German legal origin dummy.

For our basic regressions, we implement standard panel data econometric techniques accounting for fixed and random effects.[12] Panel data models capture the variation of data across units and time and control for various time-invariant unobservable characteristics (such as tax, regulation, religion, culture etc.), which may influence variations in life insurance penetration. We specify the following model:

$$LIP_{i,t} = \gamma' LTV_{i,t} + \beta' X_{i,t} + \alpha_i + \varepsilon_{i,t} \quad [1]$$

where LIP_{it} is the life insurance penetration for each country i and each period t, LTV_{it} is the average LTV ratio for each country i and each period t with its corresponding estimation parameter γ', X_{it} is time-variant vector of controls with its corresponding matrix of parameters β', α_i is the unobserved time-invariant country effect and ε_{it} is the error term. The fixed-effects model allows for correlation between the time-invariant α_i and the explanatory variables in any time period, [13] while the random-effects model assumes no correlation between them in any time period. We use the Hausman (1978) test to check for the assumption which instructs us to choose the more efficient model.[14]

The replacement of the LTV ratio with an endogenous variable, household credit to GDP ratio, requires an appropriate estimation strategy to deal with endogeneity and simultaneity problems. The GMM dynamic estimator allows us to further exploit the cross-country and time variation of data while controlling for endogeneity of the explanatory variables; the implementation is appropriate when the panel consists of a large number of countries and lower number of periods. [15] The estimator was developed by Arellano and Bond (1991) and Arellano and Bover (1995) and widely used, especially in the finance-growth literature (i.e. Beck et al., 2000; Beck and Levine, 2004). We define the following model:

$$LIP_{i,t} = \varphi' LIP_{i,t-1} + \theta' X^1_{i,t} + \mu_i + \omega_t + \epsilon_{i,t} \quad [2]$$

where $LIP_{i,t}$ represents the life insurance penetration each country i and each period t, $LIP_{i,t-1}$ is the lagged dependent variable, $X^1_{i,t}$ is the set of contemporaneous explanatory variables, μ_i is a country-specific effect, ω_t is a time-specific effect and $\epsilon_{i,t}$ is a time-varying error. The estimator tackles the

[12] Pooled OLS regressions would produce biased estimates since they ignore a possible serial correlation in composite error terms (Wooldridge, 2016).

[13] Other two assumptions are homoskedasticity and absence of serial correlation in the error terms (Wooldridge, 2016).

[14] The null hypothesis is that the random-effects model is more efficient than the fixed-effects model. The alternative is that the fixed-effects model provides consistent estimates.

[15] In our case, we have 42 countries across ten four-year periods (1980-2017), however for most of the countries the data is available during the period 1995-2017.

potential endogeneity[16] of the regressors by using internal instruments, which are defined as previous realizations of the explanatory variables. More concretely, the GMM dynamic system estimator performs simultaneous regressions in differences and levels, with lagged levels of the explanatory variables used as instruments in the differences regression, and lagged differences used as instruments in the levels regression. [17] The GMM system estimator is proven to be superior to the GMM difference estimator in terms of precision and consistency (Blundell and Bond, 1998). More efficiency and robustness to heteroskedasticity and cross correlation is gained by implementing the GMM two-step system estimator, which offers improvements in the moment weighing matrix for the cost of downward biased standard errors (Roodman, 2009). We run our model estimating the GMM two-step system estimator using Windmeijer's (2005) correction, which improves the robustness of standard errors in two-step GMM regressions. [18]

The appropriateness of the model is assessed by testing the validity of assumptions of the GMM system estimator. In fact, the consistency of the estimator depends on the validity of the instruments and absence of second-order serial correlation in the error term. We test the former using the Sargan test statistic for overidentifying restrictions, [19] while we check for the latter using the Arellano and Bond (1991) test for serial correlation. Failure to reject the null of no second-order serial correlation gives validity to our model. If, however, the error term exhibits second-order serial correlation, then we include instruments lagged one more period conditional on no serial correlation of a higher order (Loayza et al., 2000).

IV. Empirical results and discussion

Basic regressions

We perform the baseline regression similarly to Beck and Webb (2003) controlling for income level, mortality, dependency, human capital accumulation (and risk aversion) and price stability, and later extend the model with additional controls. Table 3 reports the variables' estimates within each model together with the required diagnostic tests. Whenever the Hausman test is rejected we report the fixed-

[16] More precisely, it accounts for weak exogeneity of regressors, which can be affected by current and past realizations of the life insurance penetration but must be uncorrelated with future shocks of the error term. Averaging the data extends the period by about 4 years in the future and makes this assumption plausible.

[17] The lagged differences serve as instruments to control for country-specific effects in the levels equation under the assumption that the correlation between μ_i and the levels of explanatory variables is constant over time (Beck et al., 2000).

[18] We perform our analysis in Stata using the command xtabond2 as suggested by Roodman (2009).

[19] The null is that the chosen instruments are jointly valid.

effects estimates, otherwise we rely on random-effects estimates. [20] The F-test and Wald test values suggest that all regressions are appropriately estimated with within-R-squared coefficient spanning from 7% to 20%.

The average LTV ratio is significantly negative and stable across all regressions, except in model (7) and (8). The model (1) confirms our hypothesis that relaxation of borrowing constraints (an increase in LTV ratios) hurts life insurance demand after controlling for income level, mortality, dependency, human capital accumulation (and risk aversion) and price stability.[21] To compare our results with the previous studies that examined financial development importance for life insurance demand and to capture other channels through which it may affect the demand, we include additional measures of financial development in the models (2)-(4). Only the non-household credit to GDP is significantly positive, but it does not affect the significance and magnitude of the average LTV ratio besides the sample reduction. The inclusion of too aggregate proxies in the previous studies (Outreville, 1996; Ward and Zurbruegg, 2002; Beck and Webb, 2003; Li et al., 2007) was not able to capture the effect of borrowing constraints on life insurance demand. In the remaining models (5)-(9), the insignificant coefficients deserve attention. While regression (7) is possibly mis-specified and generates unexpected results, regression (8) provides the most notable result of insignificant LTV ratio coefficient after including the real interest rate. This highlights the complexity of the interest rate effect on life insurance demand, which also captures the effect of borrowing constraints.

Our basic estimations may suffer from the heteroskedasticity issue. In the Appendix, we report the LTV ratio coefficients after running the regressions with Huber/White corrected standard errors, separately for fixed-effects and random-effects estimates. In five out of nine fixed-effects regressions, the coefficients are significantly negative at 5% and 10% confidence level, while only once significant within random-effects regressions. The validity of fixed-effects models for our full sample is implied in Table 3 where the Hausman test mainly rejects the appropriateness of random-effects models. Thus, the basic results remain significant after we correct for heteroskedasticity.

[20] For the significance of fixed-effects we include the corresponding F-test values, while for random-effects model fit we publish Wald-test p-values. High F-test values and very low Wald p-values suggest appropriate model.
[21] We refrain from providing econometric interpretation on the coefficient since our proxy is an indirect measure of borrowing constraints.

Table 3: Fixed and random effects estimations with average LTV ratio (full sample and averaged data)

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	Dependent variable: Life insurance penetration								
GDP per capita [a]	0.006	0.004	-0.008	0.006	0.029	0.008	-0.074***	0.119**	0.009
	(0.231)	(0.171)	(-0.352)	(0.224)	(1.580)	(0.320)	(-2.797)	(2.550)	(0.331)
Young dependency	-0.055**	-0.042	-0.074**	-0.055**	-0.036	-0.061**	-0.044	-0.017	-0.052*
	(-2.029)	(-1.502)	(-2.569)	(-2.003)	(-1.543)	(-2.207)	(-1.377)	(-0.391)	(-1.942)
Old dependency	-0.006	-0.000	0.027	-0.006	-0.025	-0.005	-0.017	-0.055	-0.012
	(-0.174)	(-0.000)	(0.785)	(-0.167)	(-0.859)	(-0.140)	(-0.599)	(-1.118)	(-0.345)
Life expectancy	-0.012	-0.024	-0.141*	-0.011	-0.006	-0.001	0.125**	-0.156	-0.004
	(-0.163)	(-0.338)	(-1.851)	(-0.154)	(-0.099)	(-0.017)	(2.022)	(-1.518)	(-0.063)
Inflation	0.034*	0.037*	0.032	0.034*	0.031	0.036*	0.009	0.059*	0.033*
	(1.792)	(1.965)	(1.256)	(1.788)	(1.622)	(1.873)	(0.436)	(1.858)	(1.748)
Education	0.003	0.003	0.002	0.003	0.005	0.003	0.004	0.040***	0.005
	(0.360)	(0.396)	(0.281)	(0.358)	(0.679)	(0.407)	(0.581)	(2.781)	(0.612)
LTV ratio	-0.016**	-0.015**	-0.017**	-0.016**	-0.014**	-0.017**	-0.010	-0.012	-0.018***
	(-2.363)	(-2.196)	(-2.004)	(-2.350)	(-2.152)	(-2.421)	(-1.518)	(-1.491)	(-2.677)
Financial development index		2.129							
		(1.622)							
Non-household credit to GDP			0.015***						
			(3.848)						
Financial market depth index				-0.043					
				(-0.052)					
Urbanization					0.007				
					(0.336)				
Female labor participation						-0.024			
						(-0.948)			
Social security							-0.048		
							(-1.076)		
Interest rates								-0.039	
								(-1.379)	
Rule of law									2.319*
									(1.882)
Constant	6.373	5.538	16.401***	6.366	4.217	6.878	-2.316	10.686	4.031
	(1.207)	(1.048)	(2.802)	(1.203)	(0.942)	(1.287)	(-0.529)	(1.340)	(0.748)
Observations	257	257	195	257	257	254	189	162	257
Number of economies	55	55	42	55	55	55	41	44	55
Estimation method	FE	FE	RE	FE	RE	FE	FE	FE	FE
Wald test (p-value)			0		0.0146				
F-test (p-value)	0.0206	0.0141		0.0358		0.0213	0.0919	0.0015	0.0101
Hausman test (p-value)	0.0905	0.0006	0.8971	0.0001	0.8795	0.0054	0.007	0.0002	0
Within R-squared	0.080	0.093	0.173	0.080	0.0706	0.089	0.091	0.200	0.097

*Notes: FE – fixed effects; RE – random effects; t-statistics (FE) and z-statistics (RE) in brackets; [a] scaled by 1000; *** p<0.01, ** p<0.05, * p<0.1*
Authors' calculations

Most of the controls are with the predicted signs but insignificant, however their interpretation requires caution due to possible endogeneity and multicollinearity issues. The GDP per capita is generally insignificant and positive, however it gains power after real interest rates are included and turns negative when the sample decreases and involves a social security proxy. Education does not play a significant role in explaining life insurance demand in our full sample. The secondary enrollment ratio becomes statistically significant at 1% only in model (8) when the model significantly decreases. Alternative to the risk aversion explanation,[22] the education coefficient captures the negative effect of borrowing constraints on savings as suggested by De Gregorio (1996). The higher the number of young people in the population, the lower is the demand for life insurance, which corresponds to Beck and Webb's (2003) claim that young dependency negatively affects the saving and annuity components of life insurance. Life expectancy and old dependency are mainly negative and insignificant across regressions. Inflation has an unexpected sign, although it is weakly significant at 10% confidence level. Finally, institutional development stimulates life insurance consumption confirming Ward and Zurbruegg's (2002) results.

Alternative measure, limited set of countries and annual data

The LTV ratio captures only supply-driven credit constraints; however, households may be discouraged from borrowing due to demand-driven factors (such as preferences, demographics etc.). Moreover, one may argue that tightening LTV ratios decreases credit growth, which might be related to a drop in mortgage life insurance demand. Hence, we run a dynamic GMM two-step system regression on the same set of variables by including one period lag of the dependent variable and replacing the LTV ratio with household credit to GDP ratio.[23] To avoid the problem of 'too many instruments' as suggested by Roodman (2009), only four variables, the lag of the dependent variable, household credit to GDP ratio, secondary enrollment ratio and GDP per capita, are included as internal instruments, while the rest as external. To the external instruments set we add time-invariant dummies designating the legal origin of each country to extract the exogenous component of the household credit development.[24] Since the

[22] Outreville (2015) suggests that the positive correlation between education and insurance demand does not reflect risk aversion effect.

[23] Jappelli and Pagano (1994) and De Gregorio (1996) use similar proxy for borrowing constraints.

[24] La Porta et al. (1997, 1998) show that legal origin significantly impacts the cross-country differences in creditor rights, systems for enforcing debt contracts and corporate information sharing. Djankov et al. (2007) find support to the previous relationship, namely legal origin matters for variation in creditor rights and information availability to lenders, which translates in cross-country differences in private credit to GDP ratios.

problem of second-order serial correlation is persistent, we use internal instruments lagged for three periods and more and provide the corresponding serial correlation test.

Table 4 presents the GMM two-step estimates together with the necessary diagnostics. The GMM estimates represent short-run effects of the independent variables and are not comparable to those in Table 3. Four out of nine regressions ((2), (7), (8) and (9)) are not well specified due to the low p-values of the Sargan test. The persistency of life insurance premiums is captured by the high significance of the lagged dependent variable. The household credit to GDP is significant and negative in all valid regressions which confirms our hypothesis that the more credit is available the less life insurance is demanded.[25] The coefficients are stable after adding various controls to the baseline regression. Non-household credit to GDP becomes insignificant, suggesting that it affects the life insurance penetration primarily in the longrun. Turning to the controls, we observe that GDP per capita and inflation mainly have the expected signs however they are never significant. After controlling for endogeneity, the secondary enrollment ratio becomes significantly positive and confirms the positive effects of human capital accumulation as suggested in Table1. Finally, the negative coefficient of old-dependency implies that for the older population it becomes expensive to insure against the risk of premature death.

Besides the methodological differences, the results with LTV ratio and those with household credit to GDP ratio differ due to wider coverage of countries with the former proxy. To make the results comparable across samples, we perform the equation 1 excluding the countries for which household credit to GDP data was unavailable (Appendix).

[25] It is insignificant only in model (8) where there is a big loss of observations due to unavailable data of social security proxy.

Table 4: Dynamic two-step GMM estimator with household credit to GDP (averaged data)

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	Dependent variable: Life insurance penetration								
Life insurance penetration (t-1)	1.063***	1.064***	1.061***	1.054***	1.066***	1.066***	1.033***	1.048***	1.053***
	(10.739)	(10.589)	(9.787)	(10.192)	(11.185)	(11.637)	(3.601)	(10.342)	(10.317)
GDP per capita [a]	0.007	0.005	0.007	0.003	0.011	0.006	0.013	0.007	0.011
	(0.897)	(0.430)	(0.575)	(0.291)	(1.179)	(0.724)	(1.035)	(0.379)	(1.185)
Old dependency	-0.049**	-0.048**	-0.056*	-0.048**	-0.059**	-0.049**	-0.008	-0.047	-0.057*
	(-2.461)	(-2.311)	(-1.903)	(-2.581)	(-2.260)	(-2.346)	(-0.149)	(-1.506)	(-1.839)
Young dependency	-0.018	-0.015	-0.014	-0.019	-0.010	-0.018	0.003	-0.023	-0.033
	(-1.221)	(-1.012)	(-0.967)	(-1.119)	(-0.606)	(-1.072)	(0.065)	(-1.194)	(-1.538)
Life expectancy	0.018	0.034	0.060	0.045	0.079	0.036	-0.057	0.032	0.018
	(0.305)	(0.410)	(0.693)	(0.584)	(0.944)	(0.498)	(-0.634)	(0.516)	(0.328)
Inflation	-0.003	-0.001	0.002	-0.002	0.004	-0.000	-0.027	-0.011	0.001
	(-0.244)	(-0.101)	(0.141)	(-0.153)	(0.253)	(-0.009)	(-1.256)	(-0.702)	(0.082)
Education	0.026**	0.026***	0.025**	0.024*	0.030***	0.026***	0.025**	0.014	0.027**
	(2.679)	(2.992)	(2.474)	(1.928)	(2.788)	(2.774)	(2.194)	(1.172)	(2.056)
Household credit to GDP	-0.013*	-0.015*	-0.013*	-0.017*	-0.016**	-0.016*	-0.012	-0.015*	-0.009
	(-1.898)	(-1.723)	(-1.990)	(-1.942)	(-2.223)	(-2.001)	(-0.705)	(-1.803)	(-0.976)
Financial development index		0.448							
		(0.338)							
Non-household credit to GDP			-0.002						
			(-0.455)						
Financial market depth index				0.391					
				(0.457)					
Urbanization					-0.019				
					(-1.606)				
Female labor participation						0.011			
						(1.121)			
Social security							-0.019		
							(-0.564)		
Interest rates								-0.007	
								(-1.108)	
Rule of law									-0.856
									(-1.247)
Observations	258	258	258	258	258	256	180	176	189
Number of economies	42	42	42	42	42	42	29	35	42
Number of instruments	44	45	45	45	45	45	44	45	41
AR(1) p-value	0.029	0.026	0.034	0.032	0.034	0.033	0.152	0.361	0.04
AR(2) p-value	0.015	0.018	0.018	0.017	0.015	0.016	0.009	0.038	0.056
AR(3) p-value	0.579	0.567	0.566	0.567	0.509	0.572	0.993	0.254	0.708
F-test (p-value)	0	0	0	0	0	0	0	0	0
Sargan test (p-value)	0.160	0.0870	0.146	0.131	0.243	0.219	0.0894	0.0489	0.0200

Notes: t-statistics in brackets computed with corrected standard errors according to Windmeijer (2005); time dummies included; [a] scaled by 1000; *** p<0.01, ** p<0.05, * p<0.1
Authors' calculations

In Table 5, we observe a slight increase inR-squared coefficients. The LTV ratio is negative in all regressions with strengthened significance and magnitude for most of the coefficients.[26] Since most of the excluded countries in our sample were from lower income countries, the result suggests that borrowing constraints bind for higher income countries and the result is driven by that set of countries, which is contrary to the claim that borrowing constraints may not bind in more developed countries (Loayza et al., 2000). Additionally, two proxies of financial development are highly significant and positive: financial development index and non-household credit to GDP ratio. The financial development index is a composite index capturing various channels through which it supports life insurance development.

The young dependency ratio is the second variable with consistent signs across samples, although it becomes insignificant once considered in the GMM model, which suggests long-run effects. On the contrary, the old dependency ratio shows only short-run negative effects on life insurance demand. The GDP per capita follows a similar pattern as in Table 3 and Table 4. Evidently, income is not the main determinant of life insurance demand in highly developed countries. Moreover, the weakly significant positive coefficients of inflation in Table 3 and 5 and insignificant negative, once we control for endogeneity, in Table 4, suggest that life insurance products are isolated from inflationary movements. Similarly, the coefficient of life expectancy is not stable across regressions. Whether this is the result of counter balancing the demand effect of saving and annuity life products against life term products in higher income countries remains to be explored in future research. Finally, education is mainly insignificant in the OLS regressions. The common view that the level of education reflects risk-aversion should be re-examined. The endogeneity issue of the education variable suggests that the relationship with life insurance demand is a very complex question.

To fully exploit the time variability of data, we run the regressions of Table 3 with annual data and present the results in Table 6. Increasing the variability of data causes within R-squared to drop within the range 3% - 11.6% implying that other time-variant factors contribute to the additional variation. The LTV ratio stays negative and significant at 1% and 5% confidence levels, except in models (7) and (8) as was observed in Table 3.

[26] We observe the same improvements when we run the models with robust standard errors, especially for the fixed-effects regressions (Appendix).

Table 5: Fixed and random effects estimations with average LTV ratio (limited sample and averaged data)

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	Dependent variable: Life insurance penetration								
GDP per capita [a]	0.022	0.003	-0.008	0.007	0.022	0.022	-0.137***	0.150**	0.009
	(1.038)	(0.177)	(-0.352)	(0.217)	(1.060)	(1.015)	(-3.435)	(2.518)	(0.278)
Young dependency	-0.061**	-0.019	-0.074**	-0.058	-0.061**	-0.065**	-0.054	-0.023	-0.059*
	(-2.060)	(-0.630)	(-2.569)	(-1.633)	(-2.055)	(-2.171)	(-1.213)	(-0.467)	(-1.698)
Old dependency	0.012	0.036	0.027	-0.011	0.012	0.011	-0.019	-0.063	-0.015
	(0.334)	(1.025)	(0.785)	(-0.254)	(0.323)	(0.296)	(-0.545)	(-1.135)	(-0.349)
Life expectancy	-0.071	-0.139*	-0.141*	-0.031	-0.064	-0.066	0.202**	-0.183	-0.012
	(-0.926)	(-1.915)	(-1.851)	(-0.316)	(-0.801)	(-0.859)	(2.150)	(-1.351)	(-0.128)
Inflation	0.037	0.042	0.032	0.048*	0.037	0.035	0.070	0.133*	0.048*
	(1.373)	(1.560)	(1.256)	(1.767)	(1.375)	(1.304)	(1.144)	(1.807)	(1.788)
Education	0.004	0.005	0.002	0.002	0.005	0.005	0.003	0.043**	0.004
	(0.478)	(0.536)	(0.281)	(0.199)	(0.542)	(0.557)	(0.296)	(2.620)	(0.452)
LTV ratio	-0.023**	-0.027***	-0.017**	-0.024**	-0.023***	-0.023***	-0.024**	-0.015	-0.024**
	(-2.572)	(-3.133)	(-2.004)	(-2.494)	(-2.585)	(-2.613)	(-2.278)	(-1.294)	(-2.593)
Financial development index		7.064***							
		(4.367)							
Non-household credit to GDP			0.015***						
			(3.848)						
Financial market depth index				0.527					
				(0.431)					
Urbanization					-0.008				
					(-0.314)				
Female labor participation						-0.012			
						(-0.474)			
Social security							-0.060		
							(-0.940)		
Interest rates								-0.038	
								(-0.996)	
Rule of law									2.390
									(1.612)
Constant	11.519*	11.544**	16.401***	9.192	11.538*	11.968**	-3.301	12.553	6.039
	(1.955)	(2.090)	(2.802)	(1.264)	(1.953)	(1.992)	(-0.467)	(1.201)	(0.820)
Observations	195	195	195	195	195	192	133	127	195
Number of economies	42	42	42	42	42	42	29	34	42
Estimation method	RE	RE	RE	FE	RE	RE	FE	FE	FE
Wald test (p-value)	0.00651	0	0		0.0119	0.0101			
F-test (p-value)				0.0422			0.0215	0.0012	0.0181
Hausman test (p-value)	0.4991	0.4356	0.8971	0.0381	0.9082	0.4785	0.0004	0.0004	0
Within R-squared	0.0967	0.1129	0.173	0.103	0.1009	0.1042	0.166	0.254	0.117

Notes: FE – fixed effects; RE – random effects; t-statistics (FE) and z-statistics (RE) in brackets; [a] scaled by 1000; *** p<0.01, ** p<0.05, * p<0.1
Authors' calculation

The signs and significance of the remaining variables are mainly replicated as the ones in Table 3 and 5, except for female labor participation, a significant negative sign which is contrary to the predictions of Chen et al. (2001) who speculate a positive relationship. An alternative explanation could be the effect of female labor force participation on households' financial vulnerability. The labor income of the wife lowers the financial vulnerability in case of loss of income due to husband's death and reduces the need for life insurance (Lin and Grace, 2007).

Summarizing the results, we emphasize the importance of borrowing constraints for household demand for life insurance. Life insurance products encompass risk-sharing and saving components and may be perceived as a complex package that satisfies several needs at the same time rather than being only a risk-hedging tool. The theory of life insurance demand mainly revolves around the protection aspect of life insurance policies in the context of insuring against human capital uncertainty (Yaari, 1965; Fischer, 1973; Campbell, 1980; Lewis, 1989). Although not explicitly embedded in their models, the borrowing constraints are implied in the interpretations of the models' propositions. For instance, Fischer (1973) states that life insurance serves as a tool to make large borrowings in order to avoid any bankruptcy. Additionally, Lewis (1989) claims that life insurance demand is chiefly driven by the insured's beneficiaries' preferences and constraints. Obviously, the inclusion of valuable policy options such as borrowing against cash values and surrendering of policies would have increased the complexity and tractability of their models. The positive influence of borrowing constraints illuminates how valuable the saving component together with the embedded options in life insurance policies is for households when they are facing credit constrained markets.

Table 6: Fixed and random effects estimations with average LTV ratio (full sample and annual data)

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	Dependent variable: Life insurance penetration								
GDP per capita [a]	0.018	-0.002	-0.004	0.006	0.017	0.016	-0.016	0.078***	0.011
	(1.500)	(-0.136)	(-0.271)	(0.476)	(1.454)	(1.367)	(-1.336)	(4.096)	(0.906)
Young dependency	-0.044***	-0.041***	-0.077***	-0.052***	-0.045***	-0.054***	-0.010	-0.028	-0.042***
	(-3.059)	(-2.673)	(-4.108)	(-3.379)	(-3.093)	(-3.617)	(-0.581)	(-1.370)	(-2.863)
Old dependency	-0.000	0.015	0.037*	0.006	0.001	-0.002	-0.004	-0.014	-0.002
	(-0.003)	(0.788)	(1.676)	(0.340)	(0.079)	(-0.136)	(-0.246)	(-0.557)	(-0.101)
Life expectancy	-0.012	-0.021	-0.119***	-0.018	-0.007	0.003	0.046	-0.127***	-0.006
	(-0.365)	(-0.614)	(-2.649)	(-0.531)	(-0.200)	(0.081)	(1.470)	(-2.615)	(-0.172)
Inflation	0.017*	0.020**	0.034**	0.017**	0.017**	0.021**	0.001	0.019*	0.015*
	(1.957)	(2.376)	(2.246)	(2.076)	(1.980)	(2.368)	(0.116)	(1.793)	(1.737)
Education	0.004	0.003	0.003	0.003	0.005	0.006	0.005	0.025***	0.005
	(1.105)	(0.830)	(0.633)	(0.850)	(1.219)	(1.382)	(1.297)	(3.963)	(1.194)
LTV ratio	-0.008**	-0.007**	-0.011***	-0.008**	-0.008***	-0.009***	-0.005	-0.004	-0.009***
	(-2.558)	(-2.296)	(-2.757)	(-2.531)	(-2.627)	(-2.914)	(-1.556)	(-1.212)	(-2.815)
Financial development index		2.352***							
		(4.124)							
Non-household credit to GDP			0.011***						
			(5.645)						
Financial market depth index				0.411					
				(1.226)					
Urbanization					-0.010				
					(-0.661)				
Female labor participation						-0.021*			
						(-1.769)			
Social security							-0.005		
							(-0.235)		
Interest rates								-0.009	
								(-0.902)	
Rule of law									1.511***
									(2.862)
Constant	4.856**	4.352*	14.230***	5.601**	5.185**	5.149**	-0.079	9.724***	3.436
	(1.987)	(1.707)	(4.150)	(2.192)	(2.080)	(2.087)	(-0.036)	(2.588)	(1.373)
Observations	825	825	609	825	825	806	615	503	784
Number of economies	55	55	42	55	55	55	41	44	55
Estimation method	RE	FE	RE	FE	RE	RE	RE	RE	RE
Wald test (p-value)	0		0		0	0	0.136	0	0
F-test (p-value)		0		0					
Hausman test (p-value)	0.886	0	0.9256	0	0.1768	0.8704	0.5323	0.6165	0.999
Within R-squared	0.0482	0.070	0.1155	0.052	0.0579	0.0613	0.0297	0.0956	0.048

Notes: FE – fixed effects; RE – random effects; t-statistics (FE) and z-statistics (RE) in brackets; [a] scaled by 1000; *** p<0.01, ** p<0.05, * p<0.1
Authors' calculations

V. Conclusion

Five decades of research on life insurance demand reveal that the positive influence of income and financial development and the negative one of inflation are the most supported effects. We challenge the 'one-sided' look at the relationship between financial development and life insurance demand by reflecting on the insights from the literature that deals with saving under liquidity constraints (Jappelli and Pagano, 1994; De Gregorio, 1996; Loayza et al., 2000). Jappelli and Pagano (1998) argue that households, to secure themselves against background risks or finance their current consumption, tend to save more when credit and insurance markets are underdeveloped. However, since then, credit availability and life insurance affordability have increased substantially. Despite the evolvement of credit markets, liquidity constraints are still binding in different regions in Europe (Le Blanc et al., 2015), while the embedded options in life insurance policies make the products relatively liquid saving instruments. In this new context, we test whether borrowing constraints affect saving through life insurance by drawing a broad sample of countries during the period 1980-2017. We use the average LTV ratio and household credit to GDP to proxy for the prevalence of borrowing constraints in the economy and employ appropriate econometric techniques to control for omitted variables and endogeneity issues.

Our main results show that the increase in borrowing constraints (decrease in LTV and household credit to GDP ratios) stimulates life insurance demand. The relationship stays significant after we control for other channels of financial development. Financial development affects, mostly positively, life insurance supply and demand through many channels. However, financial liberalization and the relaxation of borrowing constraints directly curb life insurance demand by decreasing households' needs to save. The effect is especially pronounced when we limit the sample to the more highly developed countries, which contradicts the view that borrowing constraints are non-binding in developed countries. The coefficients are robust to different model specifications, sample selections and time aggregating. The secondary results demonstrate that income is not the main determinant of life insurance demand in more highly developed countries, but the predominance of a young population mainly affects life insurance demand negatively in the long run. Once we control for endogeneity, we find support for the positive influence of education and the negative one of old dependency on life insurance demand. The effect of the last two is possibly very complex and requires more attention in future research.

Since our study integrates knowledge from different literature streams in life insurance and saving literature, it has broad research and policy implications. Firstly, it may explain the positive and insignificant

effects of interest rates on life insurance demand (Headen and Lee, 1974; Beenstock, 1986, Outreville, 1996; Beck and Webb, 2003). Our results suggest that a precautionary saving motive might be an essential reason for buying life insurance. Wen (2010) claims that precautionary saving under borrowing constraints may cause income growth to motivate higher savings regardless of interest rates and higher interest rates may suggest a tight credit market. Secondly, lapse literature supports the hypothesis that higher interest rates may drive lapses due to arbitrage reasons. However, higher interest rates may imply a tight credit market that may motivate termination of life insurance contracts. Whether households switch to higher-yield assets when the interest rates rise or lapse due to their inability to borrow remains an open question. Thirdly, much of the research regarding the determinants of policy loans demand evolved before the 'saving under liquidity constraints' literature. Our results are in line with the alternative fund hypothesis of this stream of literature, which suggests that life insurance policyholders demand policy loans if other crediting options are not available to them. Finally, findings of this study may bring additional insights for policymakers and managers of insurance companies. This study may indicate to policymakers that the demand for life insurance is possibly affected by the predominance of the banking sector in the financial system and increasing credit availability to households in those countries. Additionally, this study indirectly highlights the significance of embedded options (surrender and policy loan) in life insurance policies in attracting consumers, although these options are the primary reasons for the lapse risk of life insurance companies. Managers should learn how to balance this trade-off.

Appendix

Table A-1: Sample of countries

Country	Average LTV ratio (2000-2016)	Household credit to GDP (1980-2017)	Country	Average LTV ratio (2000-2016)	Household credit to GDP (1980-2017)
Australia	✓	✓	Latvia	✓	
Austria	✓	✓	Lithuania	✓	
Belgium	✓	✓	Luxembourg	✓	✓
Brazil	✓	✓	Malaysia	✓	✓
Bulgaria	✓		Malta	✓	
Canada	✓	✓	Mexico	✓	✓
Chile	✓	✓	Netherlands	✓	✓
China	✓	✓	New Zealand	✓	✓
Colombia	✓	✓	Norway	✓	✓
Croatia	✓		Poland	✓	✓
Cyprus	✓		Portugal	✓	✓
Czech Republic	✓	✓	Romania	✓	
Denmark	✓	✓	Russia	✓	✓
Estonia	✓		Saudi Arabia	✓	✓
Finland	✓	✓	Serbia	✓	
France	✓	✓	Singapore	✓	✓
Germany	✓	✓	Slovakia	✓	
Greece	✓	✓	Slovenia	✓	
Hong Kong	✓	✓	South Africa	✓	✓
Hungary	✓	✓	Spain	✓	✓
Iceland	✓		Sweden	✓	✓
India	✓	✓	Switzerland	✓	✓
Indonesia	✓	✓	Thailand	✓	✓
Ireland	✓	✓	Turkey	✓	✓
Israel	✓	✓	UK	✓	✓
Italy	✓	✓	USA	✓	✓
Japan	✓	✓	Ukraine	✓	
Korea	✓	✓			

Table A-2: Definitions and sources of variables

Variable	Definition	Source
Life insurance penetration	Life insurance premium as a % of GDP	Swiss Re
Average LTV ratio	The average LTV ratios are calculated as a simple average of all existing LTV limits on (mostly) housing loans, but also automobile loans and commercial real estate loans. If the LTV limit is absent, then the authors set 100	Alam et al. (2019)
Household credit to GDP	Credit to households and NPISHs from all sectors (% of GDP)	Bank for International Settlements
Non-household credit to GDP	The credit to households and NPISHs from all sectors is subtracted from the credit to private non-financial sector from all sectors and divided by GDP (%)	
Financial development index	Financial development index is a relative ranking of countries on the depth, access, and efficiency of their financial institutions and financial markets.	International Monetary Fund
Financial market depth index	Financial market depth index contains data on stock market capitalization to GDP, stocks traded to GDP, international debt securities of government to GDP, and total debt securities of financial and non-financial corporations to GDP	
Social security	Social security funds to GDP (%)	
GDP per capita	GDP per capita in constant 2011 US dollars.	World Bank
Life expectancy	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	
Education	Gross secondary enrollment ratio	
Inflation	Consumer price index (annual %)	
Young dependency ratio	Ratio of population under age 15 to the population ages 15-64	
Old dependency ratio	Ratio of population over age 64 to the population ages 15-64	
Urbanization	Urban population (% of total)	
Real interest rate	Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator	
Female labor force participation	Labor force participation rate, female (% of female population ages 15+)	
Rule of law	Two measures comprising one risk component. Each sub-component equals half of the total. The "law" sub-component assesses the strength and impartiality of the legal system, and the "order" sub-component assesses popular observance of the law	Political Risk Services
English legal origin	Dummy variable (1 if the country's legal system of English origin, 0 otherwise)	La Porta et al. (1997, 1998)
French legal origin	Dummy variable (1 if the country's legal system of French origin, 0 otherwise)	
Scandinavian legal origin	Dummy variable (1 if the country's legal system of Scandinavian origin, 0 otherwise)	
German legal origin	Dummy variable (1 if the country's legal system of German origin, 0 otherwise)	

Table A-3: Fixed-effects and random-effects estimates of the coefficient of average LTV ratio using different samples with averaged data and annual data (Huber/White robust standard errors)

	Method	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Dependent variable: Life insurance penetration								
Averaged data (4-year)	FE	-0.016*	-0.015	-0.019**	-0.016	-0.019*	-0.017*	-0.010	-0.012	-0.018*
		(-1.711)	(-1.492)	(-2.179)	(-1.651)	(-1.715)	(-1.719)	(-1.649)	(-1.506)	(-1.736)
	RE	-0.014	-0.013	-0.017*	-0.012	-0.014	-0.015	-0.004	-0.014	-0.018
		(-1.325)	(-1.025)	(-1.656)	(-1.034)	(-1.253)	(-1.355)	(-0.809)	(-1.126)	(-1.543)
Limited sample (42 countries)	FE	-0.023*	-0.025**	-0.019**	-0.024*	-0.029*	-0.024*	-0.024**	-0.015	-0.024*
		(-1.866)	(-2.024)	(-2.179)	(-1.987)	(-1.922)	(-1.873)	(-2.159)	(-1.640)	(-1.893)
	RE	-0.023	-0.027*	-0.017*	-0.024	-0.023	-0.023	-0.012	-0.021	-0.025
		(-1.487)	(-1.713)	(-1.656)	(-1.573)	(-1.458)	(-1.503)	(-0.923)	(-1.260)	(-1.636)
Annual data	FE	-0.008	-0.007	-0.012*	-0.008	-0.010	-0.009	-0.006	-0.004	-0.009
		(-1.447)	(-1.152)	(-1.786)	(-1.364)	(-1.470)	(-1.604)	(-1.352)	(-0.832)	(-1.412)
	RE	-0.008	-0.006	-0.011*	-0.007	-0.008	-0.009	-0.005	-0.004	-0.009
		(-1.318)	(-0.954)	(-1.688)	(-1.127)	(-1.258)	(-1.461)	(-1.101)	(-0.720)	(-1.359)

Notes: FE – fixed effects; RE – random effects; t-statistics (FE) and z-statistics (RE) in brackets; *** p<0.01, ** p<0.05, * p<0.1
Authors' calculations

References

Alam, Z., Alter, A., Eiseman, J., Gelos, G., Kang, H., Narita, M., Nier, E., & Wang, N. (2019). Digging Deeper - Evidence on the Effects of Macroprudential Policies from a New Database. IMF Working Paper, WP/19/66.

Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies*, *58*(2), 277–297. https://doi.org/10.2307/2297968

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, *68*(1), 29–51. https://doi.org/10.1016/0304-4076(94)01642-D

Bandiera, O., Caprio, G., Honohan, P., & Schiantarelli, F. (2000). Does Financial Reform Raise or Reduce Saving? *The Review of Economics and Statistics*, *82*(2), 239–263. https://doi.org/10.1162/003465300558768

Bayoumi, T. (1993). Financial Deregulation and Household Saving. *The Economic Journal*, *103*(421), 1432–1443. https://doi.org/10.2307/2234475

Beck, T., & Levine, R. (2004). Stock markets, banks, and growth: Panel evidence. *Journal of Banking & Finance*, *28*(3), 423–442. https://doi.org/10.1016/S0378-4266(02)00408-9

Beck, T., Levine, R., & Loayza, N. (2000). Finance and the sources of growth. *Journal of Financial Economics*, *58*(1–2), 261–300.

Beck, T., & Webb, I. (2003). *Economic, Demographic, and Institutional Determinants of Life Insurance Consumption Across Countries*, World Bank Economic Review, 17: 51-88.

Beenstock, M., Dickinson, G., & Khajuria, S. (1986). The determination of life premiums: An international cross-section analysis 1970–1981. *Insurance: Mathematics and Economics*, *5*(4), 261–270. https://doi.org/10.1016/0167-6687(86)90020-X

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Browne, M. J., & Kim, K. (1993). An International Analysis of Life Insurance Demand. *The Journal of Risk and Insurance*, *60*(4), 616–634. https://doi.org/10.2307/253382

Campbell, R. A. (1980). The Demand for Life Insurance: An Application of the Economics of Uncertainty. *The Journal of Finance*, *35*(5), 1155–1172. https://doi.org/10.2307/2327091

Cox, D., & Jappelli, T. (1993). The Effect of Borrowing Constraints on Consumer Liabilities. *Journal of Money, Credit and Banking*, *25*(2), 197–213.

Cummins, J. D. (1973). An Econometric Model of the Life Insurance Sector of the U.S. Economy. *The Journal of Risk and Insurance*, *40*(4), 533–554. https://doi.org/10.2307/251931

Dar, A., & Dodds, C. (1989). Interest Rates, the Emergency Fund Hypothesis and Saving through Endowment Policies: Some Empirical Evidence for the U.K. *The Journal of Risk and Insurance*, *56*(3), 415–433. https://doi.org/10.2307/253166

De Gregorio, J. (1996). Borrowing constraints, human capital accumulation, and growth. *Journal of Monetary Economics*, *37*(1), 49–71. https://doi.org/10.1016/0304-3932(95)01234-6

Djankov, S., McLiesh, C., & Shleifer, A. (2007). Private Credit in 129 Countries. *Journal of Financial Economics*, *12*(2), 77–99.

Fier, S. G., & Liebenberg, A. P. (2013). Life Insurance Lapse Behavior. *North American Actuarial Journal*, *17*(2), 153–167. https://doi.org/10.1080/10920277.2013.803438

Fischer, S. (1973). A Life Cycle Model of Life Insurance Purchases. *International Economic Review*, *14*(1), 132–152. https://doi.org/10.2307/2526049

Fissel, G. S., & Jappelli, T. (1990). Do Liquidity Constraints Vary over Time? Evidence from Survey and Panel Data. *Journal of Money, Credit and Banking*, *22*(2), 253–262.

Gemmo, I., & Götz, M. (2016). *Life insurance and demographic change: An empirical analysis of surrender decisions based on panel data* (No. 24/16). Retrieved from Goethe University Frankfurt, International Center for Insurance Regulation (ICIR) website: https://ideas.repec.org/p/zbw/icirwp/2416.html

Grant, C. (2007). Estimating Credit Constraints among US Households. *Oxford Economic Papers*, *59*(4), 583–605. Retrieved from JSTOR.

Guiso, L., & Jappelli, T. (2002). Private Transfers, Borrowing Constraints and the Timing of Homeownership. *Journal of Money, Credit and Banking*, *34*(2), 315–339. Retrieved from JSTOR.

Guiso, L., Jappelli, T., & Terlizzese, D. (1992). Saving and Capital Market Imperfections: The Italian Experience. *Scandinavian Journal of Economics*, *94*(2), 197–213.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, *46*(6), 1251–1271. https://doi.org/10.2307/1913827

Hayashi, F. (1985). The Effect of Liquidity Constraints on Consumption: A Cross-Sectional Analysis. *The Quarterly Journal of Economics*, *100*(1), 183–206. https://doi.org/10.2307/1885741

Headen, R. S., & Lee, J. F. (1974). Life Insurance Demand and Household Portfolio Behavior. *The Journal of Risk and Insurance*, *41*(4), 685–698. https://doi.org/10.2307/251963

Jappelli, T. (1990). Who is Credit Constrained in the U. S. Economy? *The Quarterly Journal of Economics*, *105*(1), 219–234. https://doi.org/10.2307/2937826

Jappelli, T., & Pagano, M. (1994). Saving, Growth, and Liquidity Constraints. *The Quarterly Journal of Economics*, *109*(1), 83–109. https://doi.org/10.2307/2118429

Jappelli, T., & Pagano, M. (1998). *The Determinants of Savings: Lessons from Italy* (No. 01). Retrieved from Centre for Studies in Economics and Finance (CSEF), University of Naples, Italy website: https://ideas.repec.org/p/sef/csefwp/01.html

Jappelli, T., & Pistaferri, L. (2000). *The Dynamics of Household Wealth Accumulation in Italy* (No. 27). Retrieved from Centre for Studies in Economics and Finance (CSEF), University of Naples, Italy website: https://ideas.repec.org/p/sef/csefwp/27.html

Kochanski, M., & Eling, M. (2013). Research on lapse in life insurance: what has been done and what needs to be done? *The Journal of Risk Finance*, *14*(4), 392–413. https://doi.org/10.1108/JRF-12-2012-0088

Kuo, W., Tsai, C., & Chen, W.-K. (2003). An Empirical Study on the Lapse Rate: The Cointegration Approach. *Journal of Risk and Insurance*, *70*(3), 489–508. https://doi.org/10.1111/1539-6975.t01-1-00061

Le Blanc, J., Porpiglia, A., Teppa, F., Zhu, J., & Ziegelmeyer, M. (2015). *Household Saving Behaviour and Credit Constraints in the Euro Area* (SSRN Scholarly Paper No. ID 2621479). Retrieved from Social Science Research Network website: https://papers.ssrn.com/abstract=2621479

Lewis, F. D. (1989). Dependents and the Demand for Life Insurance. *The American Economic Review*, *79*(3), 452–467.

Li, D., Moshirian, F., Nguyen, P., & Wee, T. (2007). The Demand for Life Insurance in OECD Countries. *Journal of Risk and Insurance*, *74*(3), 637–652. https://doi.org/10.1111/j.1539-6975.2007.00228.x

Lin, Y., & Grace, M. F. (2007). Household Life Cycle Protection: Life Insurance Holdings, Financial Vulnerability, and Portfolio Implications. *Journal of Risk and Insurance*, *74*(1), 141–173. https://doi.org/10.1111/j.1539-6975.2007.00205.x

Loayza, N., Schmidt-Hebbel, K., & Servén, L. (2000). What Drives Private Saving across the World? *The Review of Economics and Statistics*, *82*(2), 165–181.

Outreville, J. F. (1990). Whole-life insurance lapse rates and the emergency fund hypothesis. *Insurance: Mathematics and Economics*, *9*(4), 249–255. https://doi.org/10.1016/0167-6687(90)90002-U

Outreville, J. F. (1996). Life Insurance Markets in Developing Countries. *The Journal of Risk and Insurance*, *63*(2), 263–278. https://doi.org/10.2307/253745

Outreville, J. F. (2015). THE RELATIONSHIP BETWEEN RELATIVE RISK AVERSION AND THE LEVEL OF EDUCATION: A SURVEY AND IMPLICATIONS FOR THE DEMAND FOR LIFE INSURANCE: RELATIVE RISK AVERSION AND EDUCATION. *Journal of Economic Surveys*, *29*(1), 97–111. https://doi.org/10.1111/joes.12050

Pagano, M. (1993). Financial markets and growth: An overview. *European Economic Review*, *37*(2), 613–622. https://doi.org/10.1016/0014-2921(93)90051-B

Porta, R. L., Lopez-De-Silanes, F., Shleifer, A., & Vishny, R. W. (1997). Legal Determinants of External Finance. *The Journal of Finance*, *52*(3), 1131–1150. https://doi.org/10.1111/j.1540-6261.1997.tb02727.x

Porta, R. L., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W. (1998). Law and Finance. *Journal of Political Economy*, *106*(6), 1113–1155. https://doi.org/10.1086/250042

Roodman, D. (2009). How to do Xtabond2: An Introduction to Difference and System GMM in Stata. *The Stata Journal*, *9*(1), 86–136. https://doi.org/10.1177/1536867X0900900106

Stiglitz, J. E., & Weiss, A. (1981). Credit Rationing in Markets with Imperfect Information. *The American Economic Review*, *71*(3), 393–410.

Truett, D. B., & Truett, L. J. (1990). The Demand for Life Insurance in Mexico and the United States: A Comparative Study. *The Journal of Risk and Insurance*, *57*(2), 321–328. https://doi.org/10.2307/253306

Ward, D., & Zurbruegg, R. (2002). Law, Politics and Life Insurance Consumption in Asia. *The Geneva Papers on Risk and Insurance - Issues and Practice*, *27*(3), 395–412. https://doi.org/10.1111/1468-0440.00181

Wen, Y. (2010). Saving and Growth under Borrowing Constraints: -- Explaining the. *Working Paper Series*, (No. 2009-045). Retrieved from https://research.stlouisfed.org/wp/more/2009-045/

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics*, *126*(1), 25–51. https://doi.org/10.1016/j.jeconom.2004.02.005

Wood, G. L. (1964). Life Insurance Policy Loans: The Emergency Fund Concept. *The Journal of Risk and Insurance*, *31*(3), 411–420. https://doi.org/10.2307/250934

Wooldridge, J. M. (2016). *Introductory Econometrics: A Modern Approach.* Sixth Edition. Boston: Cengage Learning, 2016.

Yaari, M. E. (1965). Uncertain Lifetime, Life Insurance, and the Theory of the Consumer. *Review of Economic Studies*, *32*(2), 137–150.

Yuan, C., & Jiang, Y. (2015). Factors affecting the demand for insurance in China. *Applied Economics*, *47*(45), 4855–4867. https://doi.org/10.1080/00036846.2015.1037437

Zeldes, S. P. (1989). Consumption and Liquidity Constraints: An Empirical Investigation. *Journal of Political Economy*, *97*(2), 305–346.

Zeng, X., Carson, J. M., Chen, Q., & Wang, Y. (2016). Optimal life insurance with no-borrowing constraints: duality approach and example. *Scandinavian Actuarial Journal*, *2016*(9), 793–816. https://doi.org/10.1080/03461238.2015.1025822