



Threshold effect for the life insurance industry: evidence from OECD countries

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Abstract

We investigate the impact of new financial and economic determinants on life insurance demand for 29 OECD countries for the period 2005–2017 while controlling for a set of widely used socio-demographic and economic characteristics. Based on a panel smooth transition regression model, we find a regime-switching effect characterising the impact of bank concentration and interest rate on the size of the life insurance market, in light of the old-age dependency ratio as the threshold variable. We also show that life insurance development is boosted in countries with high scores for investment freedom and with high levels of foreign direct investment rates, regardless of the level of the old-age dependency ratio. The impact of GDP per capita on the demand for life insurance products is positive and statistically significant, regardless of the level of the threshold variable.

Keywords Life insurance density · Old-age dependency ratio · Investment freedom · Bank concentration · Foreign direct investment · Panel smooth transition regression

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Introduction

The life insurance industry has grown considerably since the early 1990s and, in the last decades, interesting developments can be observed worldwide. Despite the fact that advanced markets hold supremacy in terms of premium volume, the main 'culprit' for the decline in insurance penetration in advanced markets is the life insurance industry. For example, in advanced Europe, life insurance premiums have decreased by 1.1% annually over the past 10 years (Swiss Re 2020). Furthermore, according to Swiss Re (2018, 2019), global life premium growth slowed to 0.8% in 2018 from 1.2% in 2017 (approximately USD 2.7 trillion) and to 2.5% in 2016 from 4.4% in 2015 as advanced market premiums contracted. The effects of the 2008 financial crisis have not disappeared, and the macroeconomic context of recent years is not at all conducive to this industry. Low interest rates, inflation and slowing job growth put pressure on the profitability of life insurers from the U.S., Europe and advanced Asia–Pacific countries and engender a downturn of traditional savings insurance products for consumers.

Against this background, we expect that the life insurance industry will remain under pressure in the following years, and its sensitivity to the macroenvironment will amplify. This is the main reason we decided to deepen the analysis of macroeconomic factors that can affect the development of this sector for developed countries. Starting from this point, we have noticed that previous works looking for the main determinants for life insurance development have focused specifically on classical financial and socio-economic determinants, such as GDP per capita, inflation, real interest rate, unemployment rate, etc. (see e.g. Beck and Webb 2003; Lee et al. 2016) and, more recently, on some political, institutional and cultural determinants (Chui and Kwok 2009; Lee and Chang 2015; Lee et al. 2016; Dragoş et al. 2019). Moreover, looking at OECD countries, where the level of economic development is comparable,¹ we notice several significant disparities in the density of life insurance. From 2005 to 2017, the average value of LID was USD 4369 in the U.K. USD 1575 in the Netherlands and USD 993 in Finland. What explains these differences between high-income countries?

Given the complexity and importance of the economic and financial system for the life insurance industry, some important external factors, like foreign direct investment (FDI), the degree of investment and financial freedom and bank concentration, have received too little or no attention in the existing literature. In an attempt to fill these gaps, this paper explores the sensitivity of life insurance demand to financial, economic and institutional factors based on a non-linear approach, in light of the age structure of the population as the transition variable.

The first novelty of our study is the identification of a direct relationship between FDI and the size of the life insurance sector. Our analysis improves the existing literature by using a panel of developed countries. Empirical results show that countries with higher FDIs are associated with higher life insurance densities (LIDs).

¹ In our sample, only Turkey is an upper-middle-income economy. All other countries are high-income countries (World Bank).



Furthermore, we have strengthened the analysis of the impact of new macroeconomic factors compared to the existing literature by taking into account the investment freedom (IF) index. Together with the financial freedom (FF) index, these new determinants used in this study are part of the index of economic freedom, calculated annually and published by The Heritage Foundation. We found that the higher the investment freedom, the higher the level of LID.

Another novelty of this study is the use of the old-age dependency ratio (OADR) as a threshold variable in our non-linear model. Different age dependency ratios were used in some empirical research as driving factors for life insurance demand (Li et al. 2007; Chang and Lee 2012) but in a linear framework, which can provide some misleading conclusions considering the heterogeneity of population structure across countries. In regression models for panel data, it is usually assumed that the heterogeneity can be captured by means of individual effects and time effects, such that the coefficients of the observed explanatory variables are identical for all observations. However, in many empirical applications, this assumption may be overlooked. Moreover, some studies such as Harrington and Niehaus (2000) or Jiang and Nieh (2012) investigate the fluctuations of premiums in the insurance industry and indicate that there is a cyclical movement in insurance activities leading to a non-linear adjustment pattern.

We conducted the study based on yearly data during the period 2005–2017 for a sample of 29 OECD countries. Compared to other studies investigating similar topics, such as Beenstock et al. (1986) (for 10 countries) and Li et al. (2007) (for 25 countries), our approach relies on a larger sample and a novel econometric methodology, which allows us to investigate how a series of covariates impact the size of the life insurance market conditioned by the level of population structure. The results show a significant regime-switching effect in LID, suggesting that the financial sector is sensitive to changes in the OADR when investigating the development of life insurance markets in OECD countries.

We find a non-linear relationship between the size of the life insurance market and the interest rate but also for bank concentration. In this context, we emphasise another new determinant for LID, namely the level of bank concentration, used as a proxy for the degree of development of the financial banking system. We show that the banking and life insurance industries grow together in countries where the OADR is higher than an estimated threshold of 24.05%.

National and/or international authorities, practitioners and academics may be interested in a more in-depth analysis of new determinants of life insurance demand. Expansion of economic development at the national level remains the main channel for the development of this industry. Strategic development plans for the life insurance sector should be blended with incentives for a higher level of FDI. Considering that the level of investment freedom exhibits a significant influence on the life insurance market, local and international authorities should reduce constraints on the flow of investment capital as much as possible.

Furthermore, the development of the life insurance market can be boosted by the expansion of the banking system only in countries where the OADR level is higher than 24%. Otherwise, they can be in a competitive position for clients and their disposable financial resources for savings and investments.



Practitioners in this field could benefit from our results, knowing that the success of their business will be easier to achieve in economically and financially developed countries that are characterised by a high level of investment freedom. Moreover, in this study, academics can find the most extensive analysis of the determinants for the development of the life insurance market using a non-linear approach.

The remainder of the paper is organised as follows. In the next section, we review previous research on this topic and discuss the hypotheses. The third section describes the data and methodology. The penultimate section presents and discusses the results. The final section concludes and provides several policy implications.

Economic and financial determinants of life insurance demand: related studies and tested hypotheses

Economic factors

FDIs are one of the most important international sources of growth that can provide a relatively stable flow of funds, help to increase physical capital, technological know-how, levels of employment and skill acquisition, encourages trade, and facilitates foreign capital market access (Iamsiraroj and Ulubaşoğlu 2015; Outreville 2021). Worldwide, the level of FDI net inflows (% of GDP) has grown from 0.5% in 1970 to 5.4% in 2007, evolving inconsistently, but mostly following a descending trend in the last decade and comprising up to 2.34% of the world's GDP in 2017. Anwar (2009) found that most FDI takes place from one developed country to another. According to Siddiqui (2015), the top 30 host countries in the world, mainly industrialised countries, account for 95% of total world flows. In addition, Outreville (2021) mentioned OECD countries as the main beneficiaries of a positive balance of FDI in the financial sector.

In this context, it is recommended to use developed or industrialised countries to analyse the relationship between FDI and the size of the life insurance market. Furthermore, one of the assumptions to support the aforementioned arguments is that the profile of many insurance markets worldwide is characterised by the presence of multinational companies that can transfer technology and knowledge to their domestic suppliers (see more detailed analysis in Outreville 2021).

As an additional argument for our analysis, we expect FDI to have a favourable impact on the insurance industry, taking into account the levels of the FDI regulatory restrictiveness index for the financial services sector in OECD countries. Therefore, the average value of this index for each year, from 2006 to 2017, shows a low level of restrictiveness of FDI rules of a country (0.032, from a maximum level of 1, almost unchanged for the entire period) (OECD 2021a).

Until now, a small number of papers have examined the potential role of FDI in the insurance industry – see the excellent surveys of Alfaro and Chauvin (2020) and Outreville (2021). Fewer studies have analysed the direct relationship between FDI and the size of the (life) insurance market. Sawadogo et al. (2018), relying on a sample of 76 *developing* countries over the period 1996–2011, show that FDI increases the development of the non-life insurance market. There are several channels



through which FDI can have an influence, starting from direct investment in the insurance sector, when international insurance companies buy some local insurance companies or open branches in host countries (Sawadogo et al. 2018). In addition, multinational companies can have another positive influence on the demand for life insurance products, due to the higher wages paid to their employees than in local companies. The existing literature shows the positive effect of FDI inflows on average annual wages and minimum wages (Sawadogo et al. 2018).

Recently, the study by Carson et al. (2021), which analysed a panel of 29 countries during the period 1992–2011, focused on the life insurance market, but relied *only* on a sample of emerging economies. They showed that countries with higher FDI, particularly in the financial sector, are associated with higher penetration of life insurance.

In order for the FDI to have a beneficial effect on the development of any economic sector in a country (and we are talking in particular about the life insurance sector), it is necessary to have no restrictions regarding capital flows or, if they do exist, that they have a limited impact. Therefore, in addition to studying the impact of FDI on the development of the life insurance market in a sample of developed countries, we considered it useful to account for a new determinant of the size of this industry, such as an index to measure the level of restrictions on the flow of investment capital.

In addition to FDI, we consider the IF index, which characterises an economically free country, with no constraints on the flow of investment capital. In countries with high investment freedom, individuals and companies are allowed to move their resources into and out of specific activities, both internally and across the country's borders, without restriction. In practice, most countries have a variety of restrictions on investment, including different rules for FDI, some restricted access to foreign exchange, some restrictions on payments, transfers and capital transactions, labour regulations, corruption, weak infrastructure and political and security conditions that can affect the freedom that investors have in a market. Their negative impact is emphasised in countries where certain industries depend more on FDI.²

OECD statistics on inward FDI stocks for the financial and insurance industry (% of total FDI) at the end of the year show the value of foreign investors' equity and net loans received by companies of a specific industry resident in the reporting economy at the end of the year. In our sample, the average value of this indicator for the insurance sector, for the period 2005–2017 for the 29 OECD countries, is around 30% (OECD 2021b), but in some cases such as Luxembourg, Switzerland, Iceland and Denmark, the average values at the national level are far from the sample mean.

According to the Heritage Foundation methodology, the IF Index can also be affected by corruption, red tape and political conditions. According to the Transparency International Report (2019) regarding the corruption perception index (CPI), even countries like Denmark, Iceland and Switzerland, which have high scores for CPI, are not immune to corruption, mainly in cases of money laundering and other private-sector corruption. This research shows that 'enforcement of foreign bribery

² <https://www.heritage.org/index/investment-freedom>.



laws among OECD countries is shockingly low' (Transparency International Report 2019, p. 26). From our sample, only the U.S., Germany, the U.K., Italy, Switzerland, Norway and Israel are active enforcers.

We expect the level of FDI to be relevant for the development of the life insurance market because the level of insurance allowances could be very expensive for insurance companies, and the need for external and foreign resources can become relevant for their profitability.

Focusing only on the life insurance market and on a sample consisting of developed countries, our first hypotheses are:

Hypothesis 1 Life insurance consumption is positively influenced by the level of FDI.

Hypothesis 2 Life insurance consumption is higher in countries where the degree of investment freedom is higher.

Financial factors

The size of the life insurance sector is related to the level of financial development at the country level (Outreville 1996; Beck and Webb 2003; Li et al. 2007). Several studies have linked banking sector development with life or non-life insurance consumption (Outreville 1996; Beck and Webb 2003), but the relationship between this and the degree of competition in the banking system is still lacking in the literature. At the same time, banking development and insurance sector development were jointly selected as explanatory variables in many studies looking at the relationship between financial development and economic growth (for an in-depth analysis in this field, see Hou and Cheng 2017). Competing financial institutions (banks, pension funds, investment funds and mutual funds) can act both as alternatives to life insurance schemes that have a negative effect on the development of the industry and also as pools of capital channelled specifically through life insurance policies by institutional investors, thus stimulating the development of this industry.

In the empirical literature, several measures were used as proxies for the degree of banking system development, such as the total claims of deposit money banks on domestic non-financial sectors as a share of GDP (Outreville 1996; Beck and Webb 2003) and the ratio of M2 (money and quasi-money) to GDP. However, both perform poorly as proxies of banking system development (Levanon et al. 2015). Therefore, in contrast to the existing literature in this field, we use the level of bank concentration, defined as the ratio of the three largest banks' assets to the total assets of the banking sector, as a proxy for banking development. Compared to other performance or efficiency indicators regarding the development of the banking sector that depend on several exogenous factors (P&L reports, their repatriation etc.), the bank concentration indicator is easier to calculate and gives a clearer picture of the distribution of assets within the banking system. According to Karadima and Louri (2021), a more concentrated banking system compensates for the situations in which supervision by the authorities is not very burdensome



(especially in times of crisis), since it reduces information asymmetry between banks and their clients (regarding banking products and their performances as a whole) and, at the same time, it creates monitoring synergies between commercial banks. This indicator can thus be considered a proxy for the development of the banking system, since competition between banks shapes interest rates and, consequently, their profitability.

A developed banking system should also be effective in order to further increase customer confidence in this financial sector. We presume that the impact will also be favourable for the insurance industry in countries where the banking and life insurance markets develop together. Consequently, as another novelty of our study, we added the (FF index) to the analysis as an additional component of the economic development index, which is provided by the Heritage Foundation.

The FF index is a measure of the level of banking efficiency as well as the degree of independence from government control and interference in the financial sector. Therefore, the share of government ownership of financial institutions as part of the overall assets of the sector is one of the main components of this index. According to the most recent available OECD dataset on the size and sectorial composition of national, state-owned enterprise (SOE) sectors (2012), SOEs are valued at over USD 2 trillion and employ over 6 million people. They are highly concentrated in strategic sectors for any economy, such as telecoms, electricity and gas, transportation and postal services. At first glance, we could say that the level of state interference in the financial (insurance) sector could be limited. We took a closer look at the available data for our sample and found that in the finance sector, there are only five countries with 1–3 majority-owned listed entities and 10 countries with 1–6 minority-owned listed entities. The most common types of SOEs, found in 21 OECD countries from our sample, are the majority-owned, non-listed enterprises, varying between 1–12 enterprises per country. With two exceptions (Turkey and the Netherlands), this last type of SOE has several hundred or thousands of employees. In conclusion, some differences can be found between the OECD countries. Thus, the level of state interference could be more important in some analysed countries compared to others.

The second main component of the FF index is the degree of independence of the central bank of each country, which can affect its supervision and regulation of financial institutions and also its ability to enforce contracts and prevent fraud. How a national banking system develops is sensitive to the central bank's capability of controlling monetary instruments (Garriga 2016) and also becomes relevant for the analysis of the determinants of the size of the life insurance market. A stable and profitable banking sector may increase the confidence of consumers in other financial institutions that offer similar financial products to a certain degree (such as some types of life insurance products with a strong saving component). If the banking sector is very efficient, banks could easily raise new capital that can boost the offer of saving instruments and competition with insurance companies. The result could be cheaper and high-quality life insurance products.

In this context, Garriga (2016) provides a comprehensive dataset on de jure central bank independence (CBI). Looking at the data, while some similarities between countries can be found, there are also some discrepancies, even where their levels of economic development are similar. Thus, if the national central banks are not fully



independent, the development of the national financial systems as a whole could be affected.

Finally, the degree of FF is affected by the government ownership and control of financial institutions and, in this context, we emphasise that the impact of government bank ownership is a controversial subject. According to Cull et al. (2018), the 'social' and 'development' views stress that government-owned banks can promote social welfare and improve investments. On the contrary, the 'agency' view focuses on the agency costs associated with a government bureaucracy, which can lead to operational inefficiencies and misallocation. The data on government ownership (the asset share of banks that are more than 50% controlled by the government) for OECD countries for the year 2010 vary between 0 and 1% for the Slovak Republic, Australia, Finland, Italy and Norway, to 32% for Germany and Turkey, and up to 51% for Slovenia. Indeed, these differences are not related to the level of economic development of the country (measured through GDP/capita) and could be shaped by other cultural or political determinants. Summarising the existing literature in this field, Cull et al. (2018) highlighted that there are no substantial benefits from government bank ownership for the banking sector or the real economy, with some exceptions during financial crises.

In conclusion, regarding the relationship between the degree of development of the banking system and the size of the life insurance market, a negative sign between bank concentration and LID can be explained by high competitive pressure for insurance companies that fight with banks to attract savings from the market, which can increase the price of insurance products, while demand for them will decrease. A positive sign of correlation between them can be explained by the increase in the price of banking products, which could benefit life insurance products. Or, we can presume that the sectors behave more as friends than foes, and that they grow together. Moreover, the analysis of this correlation can be refined if we introduce the FF index into the analysis. FF can affect the attractiveness of the banking market for clients, which can also influence interest in life insurance products. Consequently, we state two hypotheses:

Hypothesis 3 Life insurance density in a country is related to the degree of development of its banking system.

Hypothesis 4 Life insurance consumption can be higher in countries where the degree of financial freedom is greater.

The usefulness of a non-linear approach with the population structure as a threshold variable

The determinants of life insurance consumption have been studied extensively. Older analyses relied mainly on time series (Neumann 1969) or on cross-sectional datasets (e.g. Beenstock et al. 1986; Curak et al. 2009). However, in recent decades, more scholars have used panel data analysis, fuelled by the increasing availability of global datasets, in a general economic context of globalisation (see Lee and Chiu



2012; Lee et al. 2013, among others). Economic and financial theories and models reveal that many economic and financial linkages are characterised by non-linear behaviour (see Lee and Chiu 2012). These analyses were expanded to the insurance industry and cyclical movements in insurance premiums and profits were revealed (Harrington and Niehaus 2000). Different studies show evidence for a non-linear relationship between life and non-life insurance premiums and income, which has led to the idea that a linear model might not be tractable when studying the insurance-income nexus (Lee and Chiu 2012). Furthermore, Lee et al. (2013) investigated the impact of country risks, including political, financial and economic risks, on the income elasticity of life and non-life insurance demand using a panel smooth transition regression (PSTR) model. We assume that changes in the relationship between various determinants (going beyond the movements of income or financial, political or economic risks) and the demand for life insurance are gradual in many countries.

The OADR (defined as the ratio of people over 65 years of age over the working-age population) is one of the main determinants of the development of the life insurance market, and results from the existing literature are mixed. In general, a positive effect on life insurance demand is expected and found (Beenstock et al. 1986; Li et al. 2007). However, Outreville (1996) found no significant relationship for a cross section of developing countries, while Li et al. (2007) and Sen and Madheswaran (2013) found a negative relationship. We consider the OADR as the threshold variable in our regression model due to the fact that, generally, in the EU (but not limited to this region), the ageing population and fast-approaching retirement of large cohorts of baby boomers exhibit a large impact, especially on pay-as-you-go pension systems.³

According to the Eurostat yearbook (2017), two trends are extremely relevant for the evolution of the OADR. First, the median age in the EU-28 has grown by 2.8 years between 2006 and 2016 (up to almost 43 years), and this growing trend is apparent in all EU member states. Second, we emphasise the progressive ageing of the older population itself and the proportion of very old people, which is growing faster than any other age segment of the EU population. The share of people aged 80 years or older in the EU-28 population is projected to more than double between 2016 and 2080, from 5.4% to 12.7%. During the period 2016 to 2080, the share of the population aged 65 years or older will represent 29.1% of the population of the EU-28 by 2080, compared to 19.2% in 2016.

³ The baby boom is generally viewed as a period of demographic rebirth in developed countries, which became visible especially in (but not limited to) those countries participating in World War II, that occurred between the mid to late 1940s and the late 1960s or early 1970s (Van Bavel and Reher 2013). Looking closely to the data for 21 European countries along with the United States and Australia (most of them were included in our sample) from Van Bavel and Reher (2013), the year in which crude birth rate is highest varies, in general, between 1944 and 1948. There are few exceptions, such as Italy, where 1939 was the year with the maximum value for crude birth rate, as well as Iceland (1950) and Poland (1951). Therefore, in many countries from our database, some members of the baby boom generation can be retired.



Consequently, changes in individuals' economic and financial behaviours are necessary and expected. Rethinking retirement provisions seems to be a clear need, but this is not the only prerequisite. Both private pension and life insurance systems should be viewed more as alternative solutions to protect retired elderly persons. Consequently, our fifth hypothesis is as follows:

Hypothesis 5 There is a non-linear relationship between life insurance density and several economic, financial and institutional determinants with a threshold effect from the old-age dependency ratio.

Data and methodology

Data

Relying on a balanced panel with 29 OECD countries (listed in Appendix 1) and yearly data starting from 2005, we used a PSTR model with OADR as a threshold variable. Due to data availability for key explanatory variables, the period under consideration ended in 2017. To avoid some misleading results, we removed outlier data points. Canada, Columbia, the Czech Republic, Estonia, Korea, Latvia, Mexico and New Zealand were excluded given their abnormal values for life insurance or due to the unavailability of data for some financial indicators. We use LID as a proxy for the size of the life insurance market, which shows the level of consumption of these types of financial products by each individual in a country without linking it to the size of the economy. The dependent, threshold and explanatory variables are presented in Table 1.

At the first stage of the analysis, we considered some additional challenger explanatory variables, such as the remained institutional variables of Kaufmann et al. (2011) (political stability and absence of violence/terrorism, government effectiveness, rule of law, control of corruption and government integrity), as well as life expectancy at birth and school enrolment. We removed them after imposing a 50% threshold in absolute values for the correlation coefficient (see Appendix 2 for further details). As a further specification, almost all of the above-mentioned institutional variables are strongly correlated (over 50%) with GDP/capita, except the political stability index. However, this index is strongly correlated with the regulatory quality index. We choose the last-mentioned index based on recent results from Dragoş et al. (2017), which showed that regulatory quality could boost the development of the life insurance market.

The variables included in the baseline specification are moderately correlated (Variance Influence Factor is lower than five). Moreover, all of the variables exhibit stationary behaviour whether we use first- or second-generation stationarity tests.⁴ The descriptive statistics are presented in Table 2.

⁴ The results are available upon request.



Table 1 Description of the variables used in the models and sources

Variables	Description and source
Life insurance density (LID)	The average annual per capita premium within a country. <i>Source: OECD insurance indicators database; Insurance Europe statistics</i>
Old-age dependency ratio (Age_Dep)	The ratio of older dependents (people older than 65) to the working-age population (those aged 15–64). <i>Source: WBID</i>
GDP per capita (GDPc)	The economy's GDP divided by its total population. <i>Source: WBID</i>
Inflation rate (Inflation)	The percentage change in Consumer Price Index. <i>Source: IMF database</i>
Interest rate (Int_Rate)	The lending interest rate adjusted for inflation as measured by the GDP deflator. <i>Source: WBID</i>
Foreign direct investment (FDI)	The direct investment equity flows in the reporting economy to GDP ratio. It is the sum of equity capital, reinvestment of earnings and other capital. <i>Source: WBID</i>
Bank concentration (BankCon)	Assets of the three largest banks as a share of assets of all commercial banks. <i>Source: WBID</i>
Remittance inflows to GDP (RI_GDP)	Net remittance inflows as a share of GDP. <i>Source: WBID</i>
Investment freedom (IF)	Characterises an economically free country, with no constraints on the flow of investment capital. <i>Source: https://www.heritage.org/index/investment-freedom</i>
Financial freedom (FF)	A measure of banking efficiency, as well as a measure of independence from government control and interference in the financial sector. <i>Source: https://www.heritage.org/index/financial-freedom</i>
Regulatory quality (RQ)	The perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. <i>Source: WBID</i>
Crisis dummy (CD)	A dummy variable equal to 1 for the year 2009 and 2010 and 0 otherwise. <i>Source: Own calculation</i>

WBID World Bank Indicators Database

Table 2 Descriptive statistics

Variable	Mean	SD	Max	Min
LID	6.87	1.54	10.84	2.30
Age_Dep (%)	23.85	6.12	45.03	8.63
GDPc	10.43	0.65	11.69	8.91
Inflation (%)	2.27	2.23	15.40	- 4.47
Int_Rate (%)	3.88	2.68	22.50	0.36
FDI (%)	6.49	16.78	252.31	- 58.32
BankCon (%)	66.75	18.45	100.00	29.95
IF	75.76	11.56	95.00	50.00
FF	70.30	12.70	90.00	30.00
RI_GDP (%)	0.96	1.15	6.05	0.14
RQ	86.21	10.03	100	57.21

Own calculations in STATA 17



Table 3 Linearity and no remaining heterogeneity tests

Test	$H_0 : r = 0$ vs. $H_1 : r = 1$	$H_0 : r = 1$ vs. $H_1 : r = 2$
Lagrange multiplier—Wald (LM _W)	20.980 (0.021)	12.478 (0.254)
Lagrange multiplier—Fischer (LM _F)	1.992 (0.033)	1.089 (0.370)
Likelihood ratio	21.586 (0.017)	12.689 (0.242)

p-values are reported in parenthesis. *Source* Own calculations in STATA 17

Panel smooth transition regression

The econometric specification relies on a Panel Transition Regression (PTR) model developed by Hansen (1999), which can be described by Eq. (1):

$$Y_{it} = \begin{cases} \mu_i + \alpha'_1 X_{it} + \varepsilon_{it}, S_{it} \leq \tau \\ \mu_i + \alpha'_2 X_{it} + \varepsilon_{it}, S_{it} > \tau \end{cases} \quad (1)$$

for $i = 1, \dots, N$ and $t = 1, \dots, T$, where N and T denote time and country dimension of the panel, respectively. In Eq. (1), the dependent variable Y_{it} is represented by LID; S_{it} is the threshold variable—OADR—and is compared to the threshold value τ in order to estimate the model; X_{it} is a vector of exogenous covariates; μ_i represents country-specific effects; and ε_{it} is the error term.

In the PSTR model, the two groups of observations—below and above the threshold—are precisely identified and distinct, with an abrupt transition from one regime to another. To account for smooth and gradual shifts via $j = 1, r$ transition functions among $r + 1$ distinct regimes, González et al. (2005) introduced the PSTR representation:

$$Y_{it} = \mu_i + \beta'_0 X_{it} + \sum_{j=1}^r \beta'_j X_{it} F(S_{it}^{(j)}; \gamma_j, \tau_j) + \varepsilon_{i,t} \quad (2)$$

In Eq. (2), we allow for r transition functions $F(S_{it}^{(j)}; \gamma_j, \tau_j)$, normalised between 0 and 1, having three key features: the threshold variable S_{it} , the slope of each transition function γ_j and the location parameters, i.e. τ_j . Following Teräsvirta (1994), we can formulate the structure of the transition function based on a logistic representation:

$$F(S_{it}^{(j)}; \gamma_j, c_j) = \left[1 + \exp\left(-\gamma \prod_{l=1}^m (S_{it} - \tau_l)\right) \right]^{-1} \quad (3)$$

with $\gamma > 0$ and $\tau_1 \leq \tau_2 \leq \dots \leq \tau_m$.



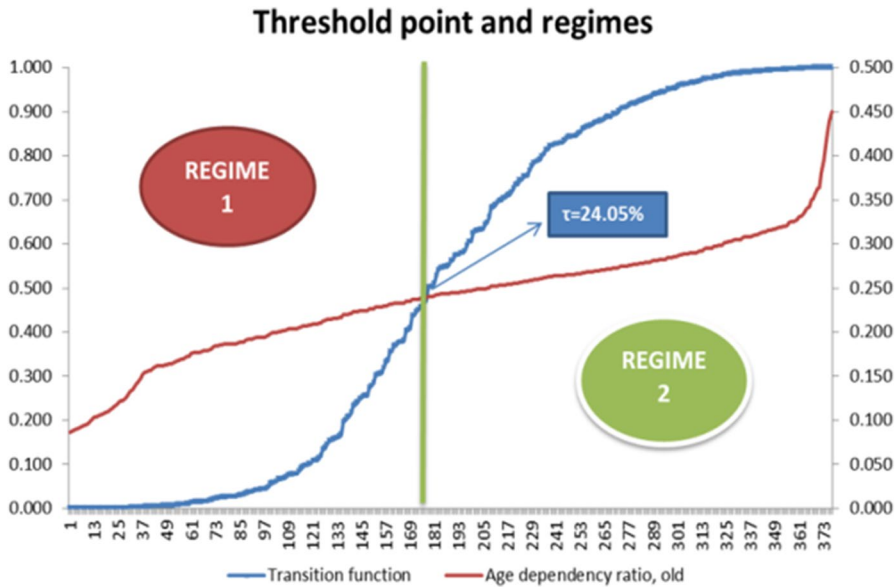


Fig. 1 Threshold function vs. transition variables

Results

Linearity investigations

Before estimating the PSTR model, following Eq. (2), we test for possible non-linear relationships within the empirical model. By employing three different linearity tests, we investigate, in the first stage, whether the regime-switching effect is statistically significant, i.e. $H_0 : r = 0$ versus $H_1 : r = 1$. The results and the corresponding p -values are presented in the second column of Table 3.

These empirical findings lead to the rejection of the null hypothesis regarding the linear relationship between LID and explanatory variables. Additionally, to make the PSTR model tractable, a supplementary investigation to quantify the number of transition functions must be carried out. Specifically, once we reject the linearity assumption, we examine whether a model with two or more transition functions can outperform a representation with only one transition function.

Based on the results highlighted in the third column of Table 3, we reject the alternative of two transition functions and accept the fact that one transition with two extreme regimes can better capture the non-linear effect in terms of LID generated by the OADR.



Table 4 Estimation results (LID as dependent variable)

Variable	Baseline model			
	β_0	β_1	Regime 1	Regime 2
GDPc	1.2210***	-0.0773	1.2210***	1.2210***
Inflation	-0.0034	-0.0079	0.0000	0.0000
Int_Rate	0.0246	-0.0402**	0.0000	- 0.0402**
FDI	0.0017**	-0.0015	0.0017**	0.0017**
BankCon	-0.0052*	0.0118***	- 0.0052*	0.0062*
IF	0.0148***	-0.0047	0.0148***	0.0148***
FF	-0.0081	0.0089	0.0000	0.0000
RI_GDP	-0.0421	0.0286	0.0000	0.0000
RQ	0.0025	-0.0091	0.0000	0.0000
CD	-0.0261	-0.0229	0.0000	0.0000
Slope	67.1879			
Threshold	0.2405			
R-squared	0.9780			

Bold was used to highlight statistically significant variables

***, ** and *denote statistical significance at the 1%, 5% and 10% levels, respectively. Source: Own calculations in MATLAB2016a

The baseline specification

In line with the recommendations presented in the previous subsection, when estimating Eq. (2), we identify one transition function with a threshold value for the OADR equal to 24.05%, which divides the sample into two extreme regimes. This value is quite close to the sample average, 23.06%, indicating a fairly balanced share of observation in the two regimes.

Figure 1 illustrates the logistic transition function versus the OADR. From a mathematical perspective, the intersection point between the two lines will have the following coordinates: the threshold value of the OADR and the inflection value, which changes the shape of the logistic transition function from convex (Regime 1) to concave (Regime 2). Furthermore, the PSTR model identifies two regimes with a smooth and gradual transition between them (the slope parameter is $\gamma = 67.19$).

In Table 4, we report the estimates of Eq. (2) considering a logistic transition function—that is, $m = 1$. When the OADR is less than 24.05%, the impact of interest rate and bank concentration is different from regime to regime. These results confirm our last hypothesis.

Identifying a threshold variable is the cornerstone of the analysis. Practically, the transition variable, together with the identified threshold, does not make a clear distinction between countries or years, but it distinguishes between the situations in which a country can be positioned in a certain year in terms of OADR. As policy implications, insurance regulators or life insurance companies can see how sensitive the dynamic of LID is to certain population cohorts and take action based on demographic aspects.



The FDI ratio positively contributes to the development of the life insurance sector, regardless of the level of the OADR. Thus, the first hypothesis is validated. A liable explanation for this relationship is the development of the life insurance sector based on foreign capital, whether associated or not with more than a capital investment, such as provisions of management or foreign technologies. Also, the sample contains mostly developed countries, which are likely to be open economies with a more skilled workforce and high growth prospects. The level of financial development of the host countries emphasises the expansion of FDI in the insurance industry (Li and Moshirian 2004; Outreville 2021).

The IF index had a positive impact on the size of life insurance from our sample of OECD countries in both regimes, with similar coefficients, regardless of whether the OADR has a level below or above the threshold of 24.05%. The second hypothesis is confirmed. The development of the life insurance market can be related, for example, to the foreign capital to set up an insurance company. Moreover, any financial, labour or fiscal restrictions or a high level of corruption could affect investment freedom. In such a framework, the business from the life insurance sector can be shaped, as well as the trust of citizens in these types of financial products.

We find no relationship between the level of the FF index and the size of the life insurance market, leading to the rejection of our third hypothesis. The lack of significance of this indicator remained, even if we removed the bank concentration variable from the regression. A possible explanation is that the level of interference of the national government in the financial sector is relatively low in the countries included in our sample. In this context, using data from Cull et al. (2018), the average value for government ownership in banks for a sample of OECD countries is around 15%, with a median value of 11%. Moreover, in the selected countries, the level of the FF index is higher compared to other countries, especially in emerging countries, compared to our sample. Consequently, we may argue that given the high level of the FF index, some intervention of general government in the financial sector, such as purchasing or selling shares to financial companies, has no effect on the insurance market.

We find that bank concentration is negatively correlated with LID in the first regime and positively correlated in the second regime. Therefore, when the OADR is below the 24.05% threshold, the impact of bank concentration is slightly lower. The banking and life insurance industries grow together in countries where the OADR is greater than 24.05%. Banking savings–investment products are preferred to insurance products when the pressure exerted by the population structure is not high, even if the banking concentration does not offer a diversified range of products (Shim 2019). On the other hand, when the population structure requires the subscription of life insurance policies, the increase in the degree of bank concentration is no longer seen as a sign of non-competitiveness. The population will consider investing in both life insurance policies and savings and investment products offered by banks.

Among the control variables, the positive coefficients show a strong and direct relationship between the level of economic development (GDP per capita) and LID, which is in line with previous findings from the existing literature. We found a negative relationship between the real interest rate and LID in the second



Table 5 Robustness checks

Variable	Model A		Model B		Model C	
	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
GDPc	1.3592***	1.1113***	1.1220***	1.1220***	0.6730***	0.6730***
Inflation	0.0000	- 0.0488**	0.0000	- 0.0522*	0.0000	- 0.0340**
Int_Rate	0.0000	- 0.0520***	0.0626***	- 0.1910***	0.0311**	- 0.0518**
FDI	0.0014***	0.0014***	0.0027***	0.0027***	0.0015***	0.0015***
BankCon	0.0039***	0.0157***	0.0000	0.0206***	0.0047***	0.0047**
IF	0.0140***	0.0008***	0.0109***	- 0.0197***	0.0046**	0.0060**
FF	- 0.0072**	- 0.0072**	- 0.0077**	0.0157**	- 0.0042	0.0019
RI_GDP	0.0000	0.4278**	0.0000	0.0000	0.0147	0.1693
RQ	- 0.0035	0.0109**	0.0000	0.0000	0.0061	- 0.0033
CD	- 0.0403	0.0565*	- 0.0551*	0.1093*	- 0.0941	0.2625***
Age_Dep	- 0.0639***	- 0.0088***	-	-		
No.obs	377		377			

***, ** and *denote statistical significance at the 1%, 5% and 10% levels, respectively. Source: Own calculations in MATLAB2016a

regime. The relationship with the real interest rate is ambiguous in the existing literature, partially justified by the manner in which it is measured (Dragoş et al. 2017). Mixed results can also be found in the literature for the life insurance–inflation rate nexus. Our results are in line with Elango and Jones (2011) and Hwang and Gao (2003), who showed an insignificant relationship between life insurance consumption and inflation rate. A similar result is recorded for the ratio of remittance inflows to GDP. The absence of any correlation with the size of the life insurance market could be explained by the characteristics of the sample, which comprises mainly developed countries. Stojanov and Strielkowski (2013) show that remittances amplify economic development in lower-middle-income and low-income countries.

It is already explained in the related literature that legal rules are important for the life insurance sector (Beck and Webb 2003). In addition, this industry can develop more if enforcement of the law is implemented. The use of World Governance Indicators (WGI) from Kaufmann et al. (2011), Beck and Webb (2003) and Lee and Chang (2015) can explain some of the variations in life insurance consumption across countries through institutional differences. The results of Chang and Lee (2012) partially support these findings but only in developing countries and, respectively, low-income countries. Lee et al. (2016) support this conclusion and, for a sample of OECD countries, confirm that in developed countries with sounder legal systems, the marginal effect of any improvement of the institutional efficiency is smaller and non-significant for the insurance sector. Similar mixed results can be found in Dragoş et al. (2017) in a sample of 32 developed emerging and transition countries in Europe. The regulatory quality is a significant institutional factor, especially for developed countries, while the rule of law significantly influences LID only in transition and emerging ones.



Our results for the regulatory quality index are in line with those studies showing that, for developed countries with sound governance, institutions play a rather passive role in the development of the insurance market (Chang and Lee 2012; Lee et al. 2016; Dragoş et al. 2019). The positive impact of institutions on life insurance development is expected mainly for developing or low-income countries.

Robustness of results

In this section, we put our results through a robustness check (Table 5). In model A, we include the threshold variable among the covariates. The linearity tests strongly reject the null hypothesis of a linear model. All coefficients, found to be statistically significant in the baseline model, retain their signs and statistical significance. In model B, we estimate Eq. (2) based on a logistic quadratic transition function—that is, $m=2$. In model C, we control for some potential endogeneity issues caused by reverse causality. Basically, we include all the independent variables, except for the crises dummy in the first lag, controlling in this way for this type of effect and implicitly for endogeneity. Most of the coefficients found to be statistically significant in the baseline model remain robust.

The evolution of the OADR is related to the size of the life insurance market, as long as life insurance products are viewed as complementary or even substitutes for public transfers (Beenstock et al. 1986).⁵ Our results seem to support a different hypothesis, and possible explanations could come from the relationship with the trends in the life expectancy indicator and with the burden of disability. One of the main conclusions of the 2017 Global Burden of Disease Study, made by the Institute for Health Metrics and Evaluation (IHME), refers to rapid progress in life expectancy from 1950 to 2017; for men, it increased from 48 years in 1950 to 71 years in 2017, and for women, it increased from 53 years in 1950 to 76 years in 2017. The prospects are that life expectancy overall will increase by 4.4 years between 2016 and 2040 (IHME 2018). In addition, the total disability burden increased by 52% between 1990 and 2017 throughout the world. Statistics on the years lived with disability from the IHME Report (IMHE 2018) revealed that the burden of disability is most concentrated in people of working age. Globally, in 2017, healthy life expectancy was only 63 years from a total life expectancy of 73 years, resulting in 10 years of life spent in poor health. If the ability to work is affected, families facing this problem will have their household income affected and will not have sufficient long-term income to support payments related to a life insurance policy. In addition, if the number of dependents (people aged 65 and over) with health problems is increasing, with a longer lifespan, the pressure on family budgets will be even greater.

⁵ The relationship between social security benefits and the demand for life insurance is ambiguous in the literature (Gaganis et al. 2019). If these benefits are seen as a household asset that increases family consumption, while the wage earner survives, the two variables can be positively correlated.



Conclusions and policy implications

In this paper, we examine how age dependency is shaping the development of the life insurance market from a threshold perspective. Alongside the OADR as a threshold variable, we consider two novel factors describing financial and economic freedom next to other determinants almost neglected in the empirical literature on this subject – bank concentration and FDI.

The homogeneity tests reveal a significant regime-switching effect, suggesting that the insurance industry is sensitive to changes in the age structure of a population, and the development of life insurance markets in OECD countries exhibit asymmetric dependencies to interest rate and bank concentration in a threshold framework.

We show that both the banking and insurance industries will develop together only in countries where the OADR has a value greater than 24.05%. Furthermore, our results suggest that developed countries with higher foreign investment tend to have a higher LID. Thus, public authorities should not lose sight of the fact that the government size, financial development and trade openness of a country shape the absorptive capacity for FDI. Additionally, life insurance development is boosted in countries with high scores for IF.

If policymakers intend to boost the insurance sector, the OADR is a very important landmark. There are three key indicators on which the modelling of this ratio depends: mortality rates, fertility rates and migration. According to the United Nations (2017), the total fertility rate is below the estimated replacement level of approximately 2.1% in OECD countries, and the outlook for 2030 (1.74%) and 2060 (1.79%) is inauspicious. The inward migration of workers exerts a positive impact on very few OECD countries. In addition, OECD countries have seen prolonged increases in life expectancy with the prospect of further growth (OECD 2017). In this complex framework, the reduction of the OADR could be achieved through a mix of medium- and long-term action policies, and the development of national life insurance industries can be a result of a common effort from national central authorities, people and private insurers. Public authorities should provide support, such as appropriate and transparent regulations; (fiscal) incentives to save for both insured people and employers to stimulate competition in the life insurance market; labour supply in later years (before retirement); overseeing demand-side barriers to the labour market; and implementing accounting and good governance standards to promote more trust in private insurance providers. Unfortunately, in recent years, the speed of pension reforms across OECD countries has slowed down (OECD 2017), and this situation must be changed in order to achieve the goal of a mature insurance industry. With an increasingly elderly population, greater retirement flexibility through solutions, such as interweaving work with pensions, part-time jobs for workers older than 60 or 65 years of age and rewards for postponing retirement, have been adopted in several OECD countries. These paths should be extended and blended, taking into account the existence of barriers in the labour market or in the cultural acceptance of part-time work, which limits the freedom of retirement decisions. Employers should offer



programmes to support a gradual exit from employment to improve the actual situation, where in Europe, for example, 78% of people over the age of 55 have no consistent opportunities for gradually retiring (OECD 2017). Together with national public authorities, employers should be involved in supporting policies to remove barriers to hiring older workers, avoid age discrimination, improve skills throughout their career and improve job quality. In the long run, through the extension of working lives, a more comfortable financial space can be offered in which life insurance policies can be included.

Good signs can be identified in the practice of some OECD states, such as Denmark, Finland and the Netherlands, where steps have been taken to gradually increase retirement age. However, we can also find negative examples, such as Poland, Canada and the Czech Republic, where the retirement age has been reduced or the decision has been postponed. At the same time, we can see the growth of the employment rate among people aged 55 to 64 years, from 44% in 2000 to almost 59% in 2016 (OECD 2017). Reliable examples from countries such as the U.S. (where 81% of employers sustain employees working past 65) and Finland (where 70% of employers and 86% of employees consider age 63 acceptable for flexible retirement) could be followed by other countries to increase the share of older people with customised employment solutions after retirement.

Additionally, people should consider that defined-benefit pension systems are increasingly unbalanced, and nowadays, the standard family is a smaller one with less cohabitation and more elderly relatives who will need public healthcare. Healthier people with longer working lives can easily underwrite and afford (often expensive) life insurance policies. As a future direction of study in this field, we intend to link the OADR with national regulations regarding retirement age because it could vary from one country to another.

Overall, in this paper, we provide some novel findings regarding the dynamic of the demand for life insurance products. However, some questions remain unanswered, especially regarding the absence of significant correlations between the size of the life insurance industry and some factors. We intend to expand our database, including the SARS-CoV-2 pandemic period, expecting new and interesting results. These are suitable topics for further research.

Appendices

Appendix 1: List of countries

Australia, Austria, Belgium, Chile, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Lithuania, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, U.K., U.S.



Appendix 2: Correlation coefficient matrix

	GDPc	Inflation	Int_Rate	FDI	BankCon	Inv_FR	Fin_FR	RI_GDP	RQ	CD
GDPc	1									
Inflation	-0.16	1								
Int_Rate	-0.35	0.45	1							
FDI	0.07	0.08	0.09	1						
BankCon	0.29	-0.11	-0.07	0.07	1					
Inv_FR	0.33	-0.15	-0.33	0.17	0.08	1				
Fin_FR	0.36	-0.03	-0.19	0.23	0.12	0.42	1			
RI_GDP	-0.09	0.02	0.02	0.02	-0.01	-0.02	-0.01	1		
RQ	0.45	-0.10	-0.30	0.18	0.23	0.47	0.48	-0.16	1	
CD	0.01	0.03	0.15	-0.06	0.01	-0.03	0.01	0.01	0.01	1

Source Own calculations in STATA 17.

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Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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