Economic Analysis and Policy 72 (2021) 186–202

Contents lists available at ScienceDirect

Economic Analysis and Policy

journal homepage: www.elsevier.com/locate/eap

Modeling economic policy issues

Country factor behavior for integration improvement of European life insurance markets☆

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ARTICLE INFO

Article history:
Received 9 June 2021
Received in revised form 12 August 2021
Accepted 12 August 2021
Available online 18 August 2021

JEL classification:
F36
G22

Keywords:
Integration
Financial market development
Institutional quality
EU life insurance markets

ABSTRACT

This paper provides evidence of the role that financial market development and institutional quality play in the integration of European Union (EU) life insurance markets. It analyzes ten EU life insurance markets over a seventeen-year sample period. The meta-technology cost/revenue efficiency ratios, estimated under the meta-frontier DEA framework, are used as a measure of integration and the analysis is conducted by applying Tobit panel regression models. We find that national stock market development and institutional quality enhance cost performance and integration of EU life insurance markets. Results also show that in countries where *bancassurance* is the main life insurance distribution channel, banking sector development contributes to integration in terms of revenue efficiency. However, we find that better outcomes in national institutional quality decrease the meta-technology revenue efficiency ratio, suggesting that life insurance prices are lower in countries with better institutions.

1. Introduction

Over the last decades, the European Union (EU) has encouraged a series of initiatives and legislative reforms with the aim to improve the integration of the EU financial services industry in order to create EU single markets in providing banking, insurance and other financial services.[1] Financial integration is expected to promote competition and efficiency in financial markets, so a way to evaluate whether EU financial integration has taken place has been analyzing convergence in efficiency across EU financial markets. Most of this literature shows that, in general, a process of financial integration has happened in the recent decades, both in EU banking markets (see e.g. Weill, 2009; Casu and Girardone, 2010; Degl'Innocenty et al., 2017; Tziogkidis et al., 2020) and in EU life insurance markets (see Cummins and Rubio-Misas, 2020).

☆ We would like to thank Professor Clevo Wilson and an anonymous reviewer for valuable comments and suggestions. The authors gratefully acknowledge financial support from the Spanish Ministry of Science, Innovation and Universities (Project RTI2018-097620-B-100) and *Universidad de Málaga Campus de Excelencia Internacional Andalucía Tech*. This paper was awarded the 2020 "*Antonio Dionis Soler*" Research Prize (*accésit*) by *Fundación de Estudios Financieros.*

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[1] In terms of legislative reforms, deregulation policies such as the 1994 Third Generation Directives (Directives 1992/49/EC and 1992/96/EC for non-life and life insurance, respectively) was a main step to promote integration in European insurance markets by removing entry barriers. The introduction of the Euro in 1999 was another step taken towards an integrated European life insurance market. Later, the EU issued new Directives for life and non-life insurers (Directives 2002/83/EC and 2002/13/EC) in order to carry out standardized solvency requirements. Afterwards, European insurers implemented Solvency II Directive (Directive 2009/138/EC). These supervisory Directives as well as other technical Directives issued by the EU during the last decades have aimed to, directly or indirectly, improve integration of EU insurance markets.

https://doi.org/10.1016/j.eap.2021.08.004

However, researchers emphasize that there are country characteristics in terms of economic and financial environment as well as other legal, cultural and institutional factors that are acting as barriers to the EU financial integration process (see e.g. Guiso et al., 2004; Berger, 2007; Cummins and Venard, 2008; Goddard et al., 2015). Yet, in spite of the relatively large number of papers analyzing convergence in efficiency across EU financial markets, we are not aware of any papers exploring country factors that prevent or contribute to the integration of EU insurance markets. Investigating country factor behavior for integration improvement is of concern for investors and managers, but particularly for regulators and policymakers, especially when a current debate exists on further EU financial integration.

This paper comes to solve this lack in literature by analyzing country characteristics influencing integration of ten EU life insurance markets over a seventeen-year sample period. The country factors we focus on are financial market development (including capital market development and banking sector development) and institutional quality (measured through governance dimensions of a country). We frame our analysis within the context of the frontier efficiency and productivity analysis and pursue to answer the following main questions: (i) Does a country's financial market development influence the integration of EU life insurance markets? (ii) Does a country's institutional quality affect the integration of EU life insurance markets? (iii) Is the role of a country's financial market development and institutional quality on integration of EU life insurance markets different in terms of cost efficiency than in terms of revenue efficiency?

To answer these questions we depart from the fact that the EU offers a heterogeneous life insurance production environment. In modern frontier efficiency and productivity methodologies, a way to take into consideration heterogeneity among groups (in our case, among countries) is using the meta-frontier framework (see e.g. (O'Donnell et al., 2008; Barros and Wanke, 2017; Le et al., 2018; Liu et al., 2020). We particularly use the meta-frontier Data Envelopment Analysis (DEA) framework. This involves estimating country frontiers as well as a meta-frontier which envelops the frontiers of all countries, taking into account that the frontiers are formed by the leading firms of the reference set in terms of efficiency. Thus, efficiency measured relative to the meta-frontier can be decomposed into two components: one that measures efficiency relative to the own-country frontier; and another one that measures technology gap, which is the distance between a country's frontier and the meta-frontier. Within this context, we argue that because financial integration is expected to promote competition and efficiency, we could expect that financial integration would imply that the leading firms in a country in terms of efficiency (these firms would be on the country frontier) would also be the leading firms in the EU in terms of efficiency (these firms would be on the meta-frontier). Based on this reasoning, technology gap can be used as a measure of integration. The lower the technology gap, the higher the level of integration. Consequently, we conduct our analysis by regressing the reciprocal of the technology gap (both in costs and in revenues) on the proxy variables of a country's financial market development and institutional quality as well as a set of control variables both at the country level and at the firm level. As stated before, this analysis would be particularly useful for policymakers and regulators because it allows knowing the behavior of these key country variables in order to design programs that involve changes in them to improve performance and integration.

Regarding the effect of a country's financial market development on the integration of EU life insurance markets, one, a priori, may expect a positive relationship. Higher levels of capital market development and banking sector development within the country where the insurer is settled facilitate raising external capital and conducting investment operations (see e.g. Levine, 1997; Beck and Webb, 2003). This could enable insurers in such countries to be dominant insurers in the EU in terms of efficiency and, hence, may contribute to reducing the gap between the country frontier and the European meta-frontier. However, we provide no directional expectation on the role that a country's institutional quality plays in the integration of EU life insurance markets. On one hand, we can expect that a lower national institutional quality impedes the development of a healthy life insurance market, affecting its performance negatively within the country and abroad (see e.g. Beck and Webb, 2003; Beck et al., 2005; Lee and Lin, 2016; Jamasb et al., 2021). On the other hand, because a country's institutional quality implies a better overall environment, lower risk-taking and fewer market frictions, one could expect lower performance and financial integration as well (see e.g. Fields et al., 2012; Marcelin and Mathur, 2014).

To sum up, this paper belongs to the growing literature on the integration of EU financial services markets by being the first, in the context of efficiency and productivity analysis, that provides evidence on country factors affecting integration among EU life insurance markets. The rest of the paper is structured as follows: Section 2 presents an overview of the life insurance industry in the analyzed EU countries; Section 3 discusses theoretical considerations; Section 4 describes the empirical modeling strategy and the data; Section 5 presents the results and discussion, followed by a concluding section.

2. Overview of the analyzed EU insurance markets

Table 1 presents figures for 1998 and 2018 of five key aspects of the insurance industry in the analyzed countries.[2] They provide a picture of the importance that the insurance industry has in each country as well as information on the

[2] Countries included in the analysis are Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, and the UK. We first selected the countries that were in the EU during all the years of the sample period. That is, we selected the EU-15 countries and excluded countries which joined the European Union in 2004, 2007 and 2013. Additionally, we excluded Finland, Greece, Ireland, Luxembourg, and Portugal due to the limited number of firms per year in some countries and the lack of homogeneous data to construct the relevant variables. The UK is included in the analysis because it was part of the EU until 2020.

Table 1
Overview of the insurance industry in the analyzed EU countries, 1998 and 2018.

	Life insurance share		Life insurance penetration		Life insurance density		Investment to GDP ratio		CR5 market share	
	1998	2018	1998	2018	1998	2018	1998	2018	1998	2018
Austria	35.70%	29.90%	2.10%	1.45%	571.6	746.3	23.40%	27.50%	56.00%	69.10%
Belgium	55.20%	54.70%	3.50%	3.50%	902.4	1623.5	40.40%	64.40%	58.00%	58.90%
Denmark	59.50%	70.00%	4.20%	7.57%	1404.6	4589.8	75.90%	87.80%	63.00%	66.20%
France	60.40%	55.20%	4.80%	5.75%	1212.8	2370.2	57.50%	102.50%	53.00%	54.40%
Germany	38.40%	31.80%	2.60%	2.41%	714.8	1161.3	40.60%	58.30%	26.00%	52.00%
Italy	51.10%	74.70%	2.30%	6.17%	518.8	2110.2	18.20%	45.20%	34.00%	62.40%
Netherlands	57.80%	16.20%	5.10%	1.72%	1424.8	912.7	65.40%	43.30%	39.00%	89.00%
Spain	46.20%	43.60%	2.20%	2.39%	336.7	731.7	12.80%	25.00%	23.00%	56.60%
Sweden	62.70%	75.60%	3.50%	4.91%	1041.0	2652.7	85.50%	91.90%	80.00%	55.90%
UK	64.50%	71.70%	9.10%	8.32%	2560.7	3531.9	105.00%	81.60%	41.00%	70.70%

This table reports figures for 1998 and 2018 of five important aspects of the insurance industry in the analyzed countries: life insurance share (calculated as life premiums to total premiums) in percentage, life insurance penetration (calculated as direct life premiums written to GDP) in percentage, life insurance density (calculated as life premiums to inhabitants) in USD per inhabitant, insurers' investment portfolio (including both life and non-life segments) to GDP in percentage and the cumulative market share of the top five life insurers (CR5) in percentage. Sources: CEA, Insurance Europe, OECD, Sigma Swiss Re.

structure of the life insurance market. These five aspects are: life insurance share, life insurance penetration, life insurance density, insurers' investment portfolio to GDP and the cumulative market share of the top five life insurers. Table 1 first presents the importance that each insurance segment (life and non-life) has within the national insurance industry. In doing so, it shows the life insurance share, which is calculated as life premiums to total premiums. We observe that from 1998 to 2018 life insurance share augmented in four out of the ten countries. Nevertheless, in countries where life insurance dominated the insurance landscape in 1998 (Belgium, Denmark, France, the UK, Italy, the Netherlands, and Sweden), this segment continued dominating in 2018, except in the Netherlands where non-life insurance dominated the insurance landscape in 2018 (OECD, 2021).

Traditionally, two measures are used to show the relative importance of insurance within national economies: insurance penetration and insurance density. Insurance penetration is the ratio of direct premium written to GDP. Related to this measure, we can see in Table 1 that life insurance penetration has increased over the sample period in five countries (Denmark, France, Italy, Spain and Sweden) but differences continue to exist. In 1998 life insurance penetration ranged from 2.1% in Austria to 9.1% in the UK, and in 2018 it ranged from 1.45% in Austria to 8.32% in the UK. Meanwhile, insurance density indicates how much each inhabitant of a country spends on insurance on average and it is calculated as the per capita annual average premiums in a country. Table 1 shows that life insurance density (life premiums per inhabitant) widely differs among countries. In 1998, it ranged from 336.7 USD in Spain to 2,560.7 USD in the UK, while it ranged from 731.7 USD in Spain to 4,589.8 USD in Denmark in 2018 (OECD, 2021).

Furthermore, since insurance companies are among the largest institutional investors, together with pension funds and investment funds, the ratio of the investment portfolio to GDP is another indicator of the relative importance of insurance in an economy. It also enables comparison of the development of the insurance sector from country to country. Table 1 shows the ratio of the investment portfolio to GDP (including both the life and the non-life segment) per country. We observe that this ratio rose from 1998 to 2018 in all countries (except in the Netherlands). However, there are important differences among them. In 1998 it ranged from 12.8% in Spain to 105% in the UK, and in 2018 it ranged from 25% in Spain to 102.5% in France (CEA, 2010; Insurance Europe, 2021). Lastly, Table 1 also shows information on the market structure of the life insurance industry in each country by providing the cumulative market share of the five top life insurers (CR5) in each country. We can see that the CR5 differs significantly among countries. In 1998, it ranged from 23% in Spain to 80% in Sweden, while in 2018 it ranged from 52% in Germany to 89% in the Netherlands (Insurance Europe, 2021). The extant differences among the analyzed EU life insurance markets reveal that we have a long way to go yet to obtain a fully integrated EU life insurance market. They also convey the importance of knowing how country factors behave for integration improvement.

3. Theoretical background

This section discusses the theoretical basis concerning the main issues analyzed in this paper and present hypotheses. As stated before, we frame our paper within the context of the growing strand of literature that studies integration of the EU financial services industry by analyzing efficiency and productivity across EU financial markets. In order to understand the contribution of our paper to literature, we highlight two key issues. On one hand, although researchers emphasize that country factors are conditioning the process of financial integration, we are not aware of any papers analyzing this issue for EU insurance markets in the context of efficiency and productivity analysis. On the other hand, most literature analyzing convergence in efficiency and productivity across EU financial markets performs the efficiency and productivity analysis on a common frontier technology, assuming that the EU offers a homogeneous production

Table 2
Definition of dependent variables and country variables.

Variable	Definition	Source
Dependent variables		
$MCER_{ijt}$	$MCER_{ijt} = Metafrontier\ cost\ efficiency_{ijt}/Country\ j\ cost\ efficiency_{it}$	
$MRER_{ijt}$	$MRER_{ijt} = Metafrontier\ revenue\ efficiency_{ijt}/Country\ j\ revenue\ efficiency_{it}$	Authors' calculation
Key explanatory variables		
	Financial market development	
Stock market development	Sock market turnover ratio. That is the ratio of the value of total shares traded to average real market capitalization.	WBDFDS
Public bond market development	Public bond market capitalization to GDP. That is public domestic debt securities issued by government as a share of GDP.	WBDFDS
Banking sector development	Private credit by deposit money banks and other financial institutions to GDP.	WBDFDS
	Institutional quality	
Political stability and absence of violence	Capturing perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including political-motivated violence and terrorism.	WBDGI
Government effectiveness	Capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	WBDGI
Regulatory quality	Capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development (Kaufmann et al., 2010, page 6).	WBDGI
Rule of law	Capturing perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	WBDGI
Institutional development	An average of six indicators measuring voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption (see (Kaufmann et al., 2010).	WBDGI
	Control variables	
CR5 life ratio	Cumulative market share of the five largest life insurers in a country.	Insurance Europe
Pension fund development	Pension fund investment as a share of GDP. An indicator of the maturity of the system and the importance of private pensions relative to the size of the economy.	OECD
Old-age dependency ratio	The number of individuals aged 65 and over per 100 people of working age defined as those aged between 20 and 64.	OECD
Size of the country's social security	Social expenditure in percentage of Gross Domestic Product. Indicator of social policy in a country. The main social policy areas are as follows: old age, survivors, incapacity-related benefits, health, family, active labor market programs, unemployment, housing and other social policy areas.	OECD

Notes: $MCER_{ijt}$ ($MRER_{ijt}$) means meta-technology cost (revenue) efficiency ratio of firm i belonging to country j in year t. $Meta-frontier\ cost$ ($revenue$) $efficiency_{ijt}$ means cost (revenue) efficiency of firm i belonging to country j in year t measured with respect to the European cost (revenue) meta-frontier. $Country\ j\ cost$ ($revenue$) $efficiency_{it}$ means cost (revenue) efficiency of firm i belonging to country j in year t measured with respect to the country j cost (revenue) frontier. WBDFDS means World Bank database on Financial Development and Structure; WBDGI means World Bank database on Governance Indicators; Insurance Europe was formerly known as Comité Européen des Assurances (CEA) until 2012. OECD means Organization for Economic Co-operation and Development.

environment. However, EU countries show a heterogeneous life insurance production environment that needs to be addressed. To our knowledge, only two recent papers analyzing EU financial integration took into account heterogeneity among countries: Casu et al. (2016) used a parametric meta-frontier Divisia index to estimate convergence in productivity across nine EU banking markets; Cummins and Rubio-Misas (2020) utilized the meta-frontier DEA framework to evaluate convergence (β-convergence and σ-convergence) in efficiency and in technology gap across ten EU life insurance markets. We follow Cummins and Rubio-Misas (2020) and take into consideration heterogeneity among countries by using the meta-frontier DEA framework to estimate the technology gap (both in costs and revenues) as a measure of financial integration. Then, we regress the reciprocal of the technology gap on variables that proxy a country's financial market development and institutional quality as well as a set of control variables both at the country level and at the firm level. Consequently, building on the paper by Cummins and Rubio-Misas (2020) we are the first who, in the context of the efficiency and productivity analysis, explore country factors that prevent or contribute to the integration of EU life insurance markets.

We focus on financial market development and institutional quality as country variables that may condition the process of integration of EU life insurance markets because literature has shown that they influence both life insurance consumption (see e.g. Beck and Webb, 2003; Li et al., 2007) and insurer performance (see e.g. Fields et al., 2012; Berry-Stölzle et al., 2013; Gaganis et al., 2015; Lee and Lin, 2016).

3.1. Financial market development and integration of EU life insurance markets

Higher levels of capital market development and banking sector development within the country where the insurer is settled facilitate raising external capital and conducting investment operations. This could enable firms in such countries to be the dominant firms in the EU in terms of efficiency and, hence, may contribute to reducing the gap between the country frontier and the European meta-frontier. From the financing side, firms can obtain external capital either through securities markets (stock and bond markets) or through the banking system. In countries where these markets are well developed, there are more opportunities to raise external capital, ameliorate information asymmetries, and reduce transaction costs (see e.g. Levine, 1997). Furthermore, from the investment side, capital market development is critical for life insurers because they are also important institutional investors and well-developed capital markets provide more opportunities to invest efficiently and earn higher investment returns.[3] In addition, well-functioning banks may provide life insurers with an efficient payment system and increase the confidence of consumers in other financial institutions such as life insurers (Beck and Webb, 2003). These arguments lead us to the following hypothesis:

H1: Financial market development contributes to integration of EU life insurance markets.

The contribution of the banking sector development to performance enhancement and integration improvement of European life insurance markets should be particularly emphasized when these two segments (the banking and the life insurance sectors) of the financial services industry converge through the *bancassurance* phenomenon. That is, in many western European countries, *bancassurance* has become the key distribution channel of life insurance products. This fact may make the effect of banking sector development on the performance of EU life insurers in countries where *bancassurance* is the main life insurance distribution channel different from countries where it is not. The bank distribution channel has some important advantages over the traditional distribution channels. Selling insurance through bank branches is known to involve lower costs than through traditional distribution systems due to cross-selling opportunities and joint back-office activities (e.g. human resources and information technology, asset management) (see e.g. Chen, 2019). Another advantage is that banks offer a form of "one stop shopping" for financial services and revenue synergies may exist if consumers are willing to pay higher prices for this kind of services (see e.g. Berger et al., 2000). Accordingly, we state the following hypothesis:

H2: The effect of banking sector development on the integration of EU life insurance markets is different in countries where bancassurance is the main life insurance distribution channel from countries where it is not.

3.2. Institutional quality and integration of EU life insurance markets

The institutional framework and political stability of each member country of the EU may affect the performance of life insurers both within the country and abroad and, hence, the integration of European life insurance markets. Consequently, we test whether differences in the quality of institutions across countries may explain the divergence among European life insurance markets. To measure institutional and political factors influencing the performance of life insurers, we focus on four dimensions of governance: (1) political stability and absence of violence, (2) government effectiveness, (3) regulatory quality, and (4) rule of law (see (Kaufmann et al., 2010). In addition, we calculate a general institutional development indicator as an average of six governance indicators: the previously mentioned four dimensions of governance along with indicators of voice and accountability and control of corruption (see e.g. Gaganis et al., 2019; Rubio-Misas, 2020).[4] These five governance indicators are measured in units ranging from about −2.5 to 2.5, with higher values corresponding to better governance outcomes. There is evidence that firms suffer as a result of institutional underdevelopment (see e.g. Beck et al., 2005). In this sense, firstly, we can think that the lack of these dimensions of governance may impede the development of a healthy life insurance market by reducing the economic horizon of both potential buyers and suppliers of life insurance products (Beck and Webb, 2003) and consequently may affect performance and integration negatively. However, given the positive relationship between risk and return, because higher levels of these variables imply a better overall environment, we could expect that this would imply lower risk-taking and fewer market frictions and, therefore, lower performance as well (see Fields et al., 2012).[5] For these reasons, we provide no directional expectation on the role that institutional quality plays in the integration of EU life insurance markets.

In the analysis of institutional and political factors affecting the performance of EU life insurers, we are aware that different dimensions of governance of a country also represent differences in a country's corporate governance model, which may explain differences in the development of financial markets (see e.g. Beck et al., 2003; Marcelin and Mathur, 2014). Consequently, we conduct both analyses (the financial market development and institutional quality analyses) separately.

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[3] Insurance companies are the largest institutional investors in the European economy, with more than 10 trillion euros worth of assets under management in 2019. The investment portfolio of EU insurers was equivalent to 58.8% of the EU GDP in 2019 and accounts for over half of all institutional investments in Europe (see European Insurance in Figs. 2019 data, available at https://www.insuranceeurope.eu/european-insurance-figures-2019-data).

[4] We do not present separate analyses on the dimensions of governance voice and accountability and control of corruption because, in general, the coefficients of these variables are not statistically significant in the multiple regression analysis.

[5] Empirical evidence on a cross-country analysis of listed insurers showed that a better operating environment decreases risk-taking without a concomitant impact on profitability (Fields et al., 2012). Yet, there is also evidence by Lee and Lin (2016) on life insurers from 30 OECD countries that a stable political institution leads insurance companies to exhibiting a better performance.

4. Empirical modeling strategy, variable definition and data

4.1. Empirical modeling strategy and variable definition

The basic model that we use in this study is specified as follows:

$$MCER_{ijt} \text{ or } MRER_{ijt} = \alpha + \beta_1 CountryKey_{jt} + \beta_2 CountryControl_{jt} + \beta_3 D_j + \beta_4 Crisis_t + \beta_5 Firmcontrol_{ijt} + \eta_{ij} + \varepsilon_{ijt} \quad (1)$$

Indices *i, j, t* stand respectively for insurer, country and year. The dependent variable which is used as a proxy of financial integration is the meta-technology cost efficiency ratio ($MCER_{ijt}$) or meta-technology revenue efficiency ratio ($MRER_{ijt}$). These ratios are estimated using the modern frontier efficiency analysis that takes into account the multidimensionality of a firm's production process. It involves measuring the performance of each firm relative to the "best practice" efficient frontiers, consisting of the dominant firms in the reference set. We particularly use the meta-frontier DEA framework that, taking into consideration the extant heterogeneity among countries, estimates country frontiers and an EU meta-frontier that envelops the frontiers of all countries (see e.g. Barros and Wanke, 2017; O'Donnell et al., 2008; Cummins and Rubio-Misas, 2020). Therefore, efficiency measured relative to the meta-frontier can be decomposed into a component that measures efficiency relative to the own-country frontier and a component that measures the meta-technology efficiency ratio, which is the reciprocal of the distance between the country frontier and the meta-frontier. Consequently, the meta-technology efficiency ratio ranges between zero and one, and the closer it is to one, the lower the distance is between the country frontier and the meta-frontier and the higher the level of integration is.[6] We conduct both the cost analysis and the revenue analysis to provide a comprehensive picture of insurer performance since, according to the traditional microeconomic theory, firms are profit maximizers by minimizing costs and maximizing revenues (see e.g. Cummins and Rubio-Misas, 2006; Cummins and Weiss, 2013). A more detailed description of the estimation procedure of the meta-technology efficiency ratio is available in Appendix.

We use Tobit regression models as meta-technology cost/revenue efficiency ratio scores fall between zero and one, thus making the dependent variable a limited dependent variable.[7] Furthermore, we adopt a Tobit random-effects regression model because our sample consists of panel data (see e.g. Peng et al., 2017, for a similar procedure). Tobit fixed-effects models are not used, basically because unconditional fixed-effects estimates are biased and do not provide a sufficient statistic to allow the fixed effects to be conditioned out of the likelihood (Wooldridge, 2002).

The $CountryKey_{jt}$ vector of variables includes the country factors allowing the analysis of the main issues of the present paper. As we stated above, these country factors are capital market development, banking sector development and institutional quality (see e.g. Beck and Webb, 2003; Li et al., 2007; Fields et al., 2012; Berry-Stölzle et al., 2013; Lee and Lin, 2016). As country control variables ($CountryControl_{jt}$) we include two variables for the main macroeconomic conditions under which the life insurers of each country are operating: the inflation rate and GDP per capita growth (see e.g. Lee and Lin, 2016; Gaganis et al., 2019). We also include a country variable capturing the structure of the life insurance market in each country, which is given by the cumulative market share of the 5 largest life insurers in each market (CR5) in terms of premiums (see e.g. Pope and Ma, 2008; Cummins et al., 2017; Eling and Schaper, 2017). In addition, we include three other country control factors: a measure of the country's social security size, a demographic variable capturing the old-age dependency ratio and a measure of the importance of private pensions in the national economy. We include them because there is empirical evidence (see e.g. Beck and Webb, 2003; Li et al., 2007) of the relationship between the first two variables and the level of insurance activity in a country. The reason for including the importance of private pensions in the national economy as a control variable is due to the fact that private pensions are important competitors of life insurers and because important differences exist among the EU countries of our sample in terms of the weight that this financial sector has in the national economy. D_j is a vector of country dummy variables to control for country effects constant over time. Furthermore, we take into account the period since the financial crisis started (i.e. 2008–2014) by including a crisis dummy variable ($Crisis_t$).

At the firm level, the control variables ($FirmControl_{ijt}$) include size, capitalization and ownership. They measure the financial and operating characteristics of firms in the industry (see e.g. Gaganis et al., 2013; Lee and Lin, 2016; Cummins et al., 2017; González-Fernández et al., 2020). We also include η_{ij} to control for unobservable insurer characteristics constant over time, and ε_{ijt} is a random error. A positive coefficient of the explanatory variable would imply that higher levels in this variable increase the meta-technology efficiency ratio and, hence, contribute to the performance and integration of European life insurance markets by reducing the gap between the country frontier and the European meta-frontier. Negative coefficients would convey the opposite implication. Table 2 provides the definition of the dependent variables and the country variables included in the regression analysis (except the two macroeconomic variables). Fig. 1 shows the mean values of the key explanatory variables per country, where we observe the wide heterogeneity that exists among the analyzed countries with respect to them.

6 The meta-technology efficiency ratio is the reciprocal of the technology gap.

7 Banker and Natarajan (2008) and Banker et al. (2019) show that this two-stage procedure yields consistent estimates. Consistency appears under the generally non-restrictive conditions that the production function is monotone increasing and concave and separable from a parametric function of the contextual variables. They also demonstrate that the two-stage DEA-regression procedure performs as well as the best parametric (econometric) methods.

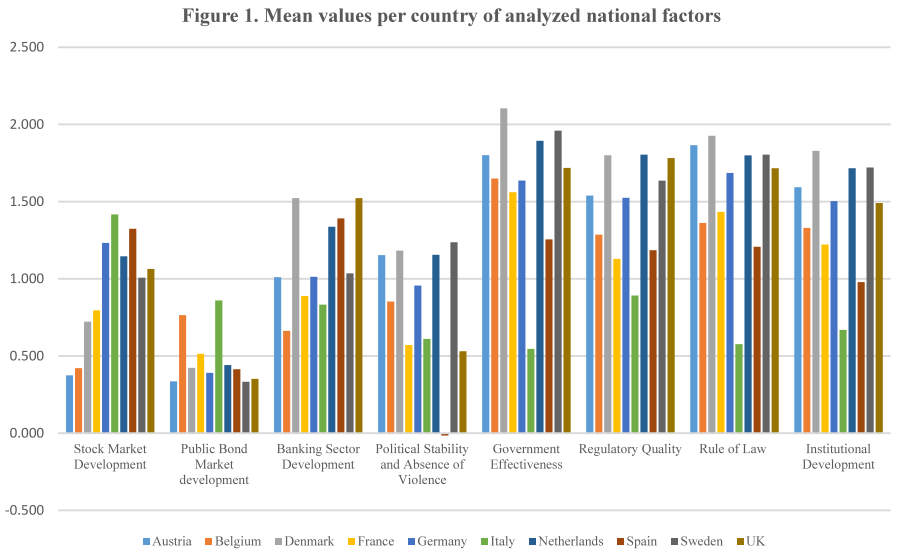

Fig. 1. Note: This figure reports mean values of the key explanatory variables per country. Measures of financial market development were obtained from the World Bank database on financial development and structure. The governance dimensions of the country were obtained from the World Bank database on governance indicator.

4.2. Data and sources

Our sample consists of an unbalanced panel of life insurers from ten EU countries (Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, and the UK) spanning a seventeen-year-period from 1998 to 2014. As stated before, we select the countries based upon the length of time they have been in the EU and also on considerations of data availability. To construct the relevant variables of interest per firm we used annual financial statements, which were obtained from the Orbis Insurance Focus dataset provided by Bureau van Dijk. We use reports prepared under International Financial Reporting Standards/International Accounting Standards (IFRS/IAS) where they exist. Otherwise, we use reports prepared under local generally accepted accounting principles. Unconsolidated data are used for unaffiliated single insurance companies and consolidated data are used for groups of insurers. Unaffiliated insurers are linked to the country where they are domiciled. Groups of insurers are associated to the country where the group is domiciled, although a group may have subsidiaries domiciled in different countries from the group. Groups' subsidiaries are not included to avoid double counting. The final sample is a result of a series of screening tests. We eliminated non-viable firms such as firms with non-positive invested assets, equity capital, total debt, incurred benefits, net premiums or operating expenses. The final sample includes a total of 8,594 firm–year observations. All monetary variables are expressed in millions of euros and deflated by the country-specific Consumer Price Index (CPI) to the base year 2000, which were obtained from the International Labor Organization (ILO).

The country level data were obtained from a variety of sources. Information on capital market development and banking sector development were collected from the updated version of the World Bank database on financial development and structure (Beck et al., 2010; Cihák et al., 2012). The governance dimensions of the country were obtained from the updated World Bank database on governance indicators (Kaufmann et al., 2010). The ratio of the market share held by the five largest life insurers in each national market was obtained from the European Insurance and Reinsurance Federation, Insurance Europe. Growth in real per capita GDP was sourced from the World Development Indicators and inflation rates from the Eurostat database. Information on the size of the country's social security, the importance of private pensions in the national economy as well as the old-age dependency ratio of the country where the insurer is settled, were collected from the OECD Economic Outlook database. Table 3 reports the descriptive statistics for the variables included in the regression analysis. We highlight from this table that the mean (median) values for the MCER and MRER are 0.9177 (0.9447) and 0.5532 (0.5782), respectively. These figures indicate that, on average, the technology gap between the country frontiers and the EU meta-frontier is higher in terms of revenue efficiency than in terms of cost efficiency for the analyzed EU life insurance markets over the sample period.

5. Results and discussion

This section presents results of the multiple regression analysis using the Tobit random-effects regression model.[8] As we stated above, the analysis of the effects of financial market development on the meta-technology efficiency ratios is conducted separately from the analysis of the effects of institutional quality on them.

5.1. Financial market development and meta-technology efficiency ratios

The regression results on the effects of financial market development on the meta-technology efficiency ratios are presented in Tables 4 and 5 for the cost and revenue analysis respectively. We show results from 8 models. A correspondence exists between the models of the two tables in terms of the included variables. Model 1 involves the two macroeconomic variables, the market concentration variable, two out of three additional country control variables (that is, variables proxying for the size of a country's social security and the old-age dependency ratio), the firm-level control variables, the crisis dummy variable, the country dummy variables as well as the country key variables measuring the stock market development and the banking sector development. Model 2 additionally includes the variable proxies for the importance of private pensions in the national economy. This last variable is not included in all the models because of lack of data availability (that is, there is no information on it for most of the countries of the sample for the first three years of the sample period). Model 3 adds the public bond sector development variable to Model 1. Again this last variable is not included in all the models because of shortage of data availability (in this case, there are no data on it for an important number of countries for the last three years of the sample period).

Model 4 adds the proxy variables for the importance of private pensions in the national economy and public bond sector development to Model 1, reducing the sample size to 5637 observations. Subsequently, to test hypothesis H2, that is, if the effect of banking sector development on the integration of EU life insurance markets is different in countries where *bancassurance* is the main life insurance distribution channel than in countries where it is not, we include the *bancassurance* interaction term. This interaction term is formed by a dummy variable (that takes 1 if *bancassurance* is the main life insurance distribution channel in this country, that is, for Austria, Belgium, France, Italy and Spain) and the level of banking sector development.[9] As a consequence, Models 5 to 8 present the results of the regressions where this *bancassurance* interaction term is included along with the corresponding variables involved in Models 1 to 4, respectively.

Because security markets incorporate both stock and debt markets, we use two variables to measure the level of capital market development in a country. The stock turnover ratio, which measures the activity or liquidity of the stock market relative to its size, (see e.g. Beck et al., 2010) is used to proxy for the level of development of the stock market. Our proxy for debt market development is the ratio of public bond market capitalization to GDP.

All regression models in Table 4 show a positive and significant relationship between the level of stock market development and the meta-technology cost efficiency ratio. This provides evidence that the higher the liquidity of the stock market of the country where the firm is headquartered, the lower the gap between the country cost frontier and the European cost meta-frontier. The results also show a positive and significant relationship between the size of the debt market and the meta-technology cost efficiency ratio in the 4 regressions where this variable is included. These results support hypothesis H1. They confirm our expectation that higher levels of capital market development within the country where the insurer is settled facilitate raising external capital and also conducting investment operations, making the leading firms in the country being the leading firms in the EU in terms of cost minimization. These results, at some point, are in line with the ones by Eling and Schaper (2017) who found a positive relationship between stock market development and cost efficiency of EU life insurers.

The level of banking sector development is proxied by private credit by deposit money banks and other financial institutions to GDP (see e.g. Arena, 2008; Cummins et al., 2017). This variable is negative and significant in Models 1 to 4 in the cost analysis (see Table 4) but positive and significant in the same models in the revenue analysis (see Table 5). These results first suggest that higher levels of banking sector development contribute to increasing the gap between the country cost frontier and the European cost meta-frontier but to decreasing the gap between the country revenue frontier and the European revenue meta-frontier. These results may be indicating a cost penalty of leading insurers in countries where the level of banking sector development is more developed but a revenue compensation as well.

Nevertheless, as stated above we also test hypothesis H2, performing this analysis by including the *bancassurance* interaction term. Results are presented in Models 5 to 8 in Tables 4 and 5 for the cost and revenue analysis, respectively. For all the specifications, the coefficient of the banking sector development variable remains negative and significant in the cost analysis (see Table 4). Yet, it is especially remarkable that the *bancassurance* interaction term is always positive and statistically significant now (at 1%) both in the cost and the revenue analyses. This result supports hypothesis H2. All in all, these findings seem to indicate that in countries where *bancassurance* is not the key distribution channel, banking sector

[8] As a robustness test, we also conducted the multiple regression analysis by using panel data fixed effects. Results (available upon request) from this analysis with respect to the key variables are generally consistent with the results provided in the paper by using Tobit random-effects regressions. Yet, we did not include country fixed effects in the analysis because country dummies are time invariant.

[9] It would be preferable to use information on distribution channels at the firm level instead of using this dummy variable. However, the data to do so are not available.

Table 3
Summary statistics: Variables in the regression analysis.

	Mean	Median	Std. dev.	P10	P90
Dependent variables					
Meta-technology cost efficiency ratio (MCER)	0.9177	0.9447	0.1149	0.8334	0.9997
Meta-technology revenue efficiency ratio (MRER)	0.5532	0.5782	0.3126	0.1398	0.9820
Key explanatory variables					
Capital market development					
Stock market development	1.1254	1.0632	0.4853	0.5915	1.7000
Public bond market development	0.4583	0.4107	0.1688	0.2964	0.7909
Banking sector development					
Banking sector development	1.1263	1.0835	0.3376	0.8041	1.6851
Governance dimensions					
Political stability and absence of violence	0.7584	0.8422	0.4193	0.1952	1.2417
Government effectiveness	1.7001	1.6611	0.1969	1.5060	1.9780
Regulatory quality	1.5445	1.5548	0.1865	1.2499	1.7030
Rule of law	1.6899	1.6649	0.1948	1.3438	1.8568
Institutional development	1.4600	1.4800	0.2072	1.1200	1.6800
Control variables					
Macroeconomic variables					
Inflation rate	1.8197	1.8000	0.9271	0.6000	2.9000
Growth in real per capita GDP	0.8999	1.3000	2.1080	−1.3830	2.9000
Concentration					
Cumulative market share 5 largest insurers	0.4898	0.5012	0.1387	0.3100	0.6900
Size of a country's social security					
Social expenditure in percentage of GDP	24.96	25.38	2.92	19.91	28.61
Private pension development					
Investment as a share of GDP	21.28	5.52	33.00	2.68	76.28
Demographic variable					
Old-age dependency ratio	29.48	28.80	3.36	25.60	34.60
Firm level control variables					
Size (Log of total assets)	6.0771	6.1419	0.9587	4.7701	7.2915
Equity capital/Total assets	0.1021	0.0470	0.1592	0.0130	0.2434
Group	0.0812	0.0000	0.2732	0.0000	0.0000
Number of observations			8594 (a)		

This table reports summary statistics (mean, median, standard deviation, percentile 10 (P10) and percentile 90 (P90)) of variables included in the regression analysis. (a) The number of observations to calculate descriptive statistics of public bond market development and private pension plan development was 7205 and 7026, respectively.

development has a cost penalty in the performance of leading life insurers. However, in countries where *bancassurance* is key, in addition to this cost penalty, it seems that there is a cost compensation. In the revenue analysis, results indicate that the positive revenue effect of banking sector development occurs in countries where *bancassurance* is essential. As we stated above, the positive effect of *bancassurance* as a distribution channel, on the cost side, could be because selling insurance through banks could be less expensive than using traditional distribution channels. The positive effect, on the revenue side, could be as a consequence of banks offering a form of "one stop shopping" for financial services and revenue synergies may exist when consumers are willing to pay higher prices for this kind of services. Consequently, our results on *bancassurance* interaction term provide certain evidence of synergies between life insurers and banking and suggest that the *bancassurance* architectural structure for financial firms offers some benefits. These findings are in line with literature providing evidence of the existence of synergies in the convergence of these two financial services (e.g. Fields et al., 2007).

5.2. Institutional quality and meta-technology efficiency ratios

The analysis of the effect of institutional quality on the meta-technology efficiency ratios through governance dimensions of the country where the firm is headquartered is presented in Models 1 to 5 of Tables 6 and 7, for the cost and revenue analysis, respectively. A correspondence exists between the models of the two tables in terms of the included variables. As we stated above, we do not include the proxy variables for financial market development now. That is, we do not include stock market development, banking sector development, public bond market development and private pension development. In addition, as governance dimension measures are correlated they are included one by one.

Results show that the coefficients of the political stability and absence of violence, regulatory quality and institutional development variables are positive and statistically significant in the cost analysis (see Table 6). These results indicate that the higher the level of these dimensions of governance, the easier the development of a healthy life insurance market by increasing the economic horizons of both potential buyers and suppliers of life insurance products, contributing to national leaders being leaders in the EU in terms of cost minimization. These findings are, in some way, in line with previous results

Table 4
Meta-technology cost efficiency ratio and financial market development.

Model	1		2		3		4		5		6		7		8	
Key variables																
Financial market development																
Stock market development	0.018	***	0.015	***	0.020	***	0.020	***	0.019	***	0.016	***	0.021	***	0.021	***
Public bond market development					0.021	*	0.097	***					0.033	***	0.105	***
Banking sector development	−0.049	***	−0.041	***	−0.046	***	−0.026	***	−0.056	***	−0.059	***	−0.051	***	−0.048	***
Bancassurance									0.029	***	0.046	***	0.034	***	0.056	***
Control variables																
Country factors																
Inflation	0.009	***	0.010	***	0.006	***	0.005	***	0.009	***	0.010	***	0.006	***	0.006	***
GDP per capita growth	0.001	***	0.001	***	0.002	***	0.001	***	0.001	***	0.001	**	0.002	***	0.001	**
Concentration (CR5)	−0.004		−0.007		−0.030	***	−0.041	***	−0.012	*	−0.016	**	−0.045	**	−0.060	***
Social security size	0.008	***	0.007	***	0.008	***	0.005	***	0.008	***	0.007	***	0.008	***	0.005	***
Private pension development			−0.001	***			−0.001	***			−0.001	***			0.000	**
Old-age dependency ratio	−0.006	***	−0.006	***	−0.005	***	−0.005	***	−0.006	***	−0.006	***	−0.005	***	−0.005	***
Firm characteristics																
Size	0.032	***	0.031	***	0.027	***	0.023	***	0.032	***	0.031	***	0.026	***	0.023	***
Capitalization	−0.133	***	−0.123	***	−0.143	***	−0.143	***	−0.134	***	−0.122	***	−0.144	***	−0.142	***
Group	0.004		0.005		0.012	**	0.015	***	0.005		0.006		0.012	**	0.015	**
Crisis dummy	0.003		0.009	***	0.007	***	0.011	***	0.003		0.007	***	0.008	***	0.010	***
Country dummies	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Log likelihood	12,382		10,545		10,570		8664		12,390		10,557		10,580		8678	
Observations	8594		7026		7205		5637		8594		7026		7205		5637	

This table reports the results of estimating Eq. (1) using Tobit random-effects regression models, where the dependent variable is the meta-technology cost efficiency ratio. The key explanatory variables are measures of national financial market development. These explanatory variables as well as the country Control variables (except the two macroeconomic variables) are defined in Table 2. The *bancassurance* variable is an interaction term that is formed by a dummy variable that takes 1 if *bancassurance* is the main life insurance distribution channel in this country and the level of banking sector development. Additionally, we include size (calculated as the log of assets), capitalization (calculated as equity capital to total assets) and group (equal to 1 if the decision-making unit is a group of insurers) as Firm level control variables. A crisis dummy variable is also included to control for the period since the financial crisis started. Coefficients for intercept and country dummy variables are not reported. ***, ** and * mean statistical significance at 1%, 5% and 10%, respectively.

Table 5
Meta-technology revenue efficiency ratio and financial market development.

Model	1		2		3		4		5		6		7		8	
Key variables																
Financial market development																
Stock market development	−0.002		−0.001		−0.002		0.000		0.003		0.003		0.003		0.003	
Public bond market development					−0.064	***	0.031						−0.013		0.053	*
Banking sector development	0.046	***	0.054	***	0.034	***	0.071	***	0.013		0.006		0.011		0.011	
Bancassurance									0.145	***	0.121	***	0.151	***	0.151	***
Control variables																
Country factors																
Inflation	0.004	**	0.002		0.005	***	0.002		0.003	**	0.003	*	0.004	**	0.003	*
GDP per capita growth	0.001	**	0.002	***	0.001	*	0.002	**	0.001	**	0.001	**	0.001		0.000	
Concentration (CR5)	0.069	***	0.050	***	0.088	***	0.052	***	0.027	**	0.028	**	0.026		0.001	
Social security size	0.005	***	0.002		0.006	***	0.000		0.003	***	0.003	**	0.002		−0.001	
Private pension development			0.001	**			0.000				0.001	***			0.001	**
Old-age dependency ratio	0.000		−0.001		0.001		−0.001		0.000		−0.001		0.000		−0.001	
Firm characteristics																
Size	0.097	***	0.095	***	0.107	***	0.108	***	0.095	***	0.095	***	0.104	***	0.109	***
Capitalization	−0.223	***	−0.212	***	−0.201	***	−0.178	***	−0.228	***	−0.211	***	−0.206	***	−0.176	***
Group	0.006		0.003		−0.009		−0.013		0.008		0.006		−0.007		−0.014	
Crisis dummy	0.020	***	0.023	***	0.017	***	0.023	***	0.019	***	0.019	***	0.018	***	0.019	***
Country dummies	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Log likelihood	6995		5691		5897		4551		7048		5711		5946		4574	
Observations	8594		7026		7205		5637		8594		7026		7205		5637	

This table reports the results of estimating Eq. (1) using Tobit random-effects regression models, where the dependent variable is the meta-technology revenue efficiency ratio. The key explanatory variables are measures of national financial market development. These explanatory variables as well as the country Control variables (except the two macroeconomic variables) are defined in Table 2. The *bancassurance* variable is an interaction term that is formed by a dummy variable that takes 1 if *bancassurance* is the main life insurance distribution channel in this country and the level of banking sector development. Additionally, we include size (calculated as the log of assets), capitalization (calculated as equity capital to total assets) and group (equal to 1 if the decision-making unit is a group of insurers) as firm-level Control variables. A crisis dummy variable is also included to control for the period since the financial crisis started. Coefficients for intercept and country dummy variables are not reported. ***, ** and * mean statistical significance at 1%, 5% and 10%, respectively.

Table 6
Meta-technology cost efficiency ratio and institutional quality.

Model	1		2		3		4		5	
Key variables										
Governance dimensions										
Political stability and absence of violence	0.022	***								
Government effectiveness			−0.003							
Regulatory quality					0.024	***				
Rule of law							−0.007			
Institutional development									0.036	***
Control variables										
Country factors										
Inflation	0.010	***	0.009	***	0.009	***	0.009	***	0.009	***
GDP per capita growth	0.000		0.001	**	0.001	**	0.001	**	0.001	*
Concentration (CR5)	0.007		−0.005		−0.004		−0.005		−0.001	
Social security size	0.006	***	0.004	***	0.004	***	0.004	***	0.005	***
Old-age dependency ratio	−0.003	***	−0.004	***	−0.004	***	−0.004	***	−0.003	***
Firm characteristics										
Size	0.031	***	0.029	***	0.029	***	0.029	***	0.030	***
Capitalization	−0.135	***	−0.138	***	−0.138	***	−0.138	***	−0.137	***
Group	0.010	*	0.010	**	0.010	*	0.010	**	0.011	**
Crisis dummy	−0.004	**	−0.001		0.000		−0.001		−0.002	
Country dummies	Yes		Yes		Yes		Yes		Yes	
Log likelihood	12,274		12,245		12,249		12,245		12,252	
Observations	8594		8594		8594		8594		8594	

This table reports the results of estimating Eq. (1) using Tobit random-effects regression models, where the dependent variable is the meta-technology cost efficiency ratio. The key explanatory variables are measures of institutional quality. These explanatory variables as well as the country Control variables (except the two macroeconomic variables) are defined in Table 2. Additionally, we include size (calculated as the log of assets), capitalization (calculated as equity capital to total assets) and group (equal to 1 if the decision making unit is a group of insurers) as Firm level control variables. A crisis dummy variable is also included to control for the period since the financial crisis started. Coefficients for intercept and country dummies variables are not reported. *** ,** and * mean statistical significance at 1%, 5% and 10%, respectively.

by Lee and Lin (2016) who found that a stable political institution fosters better performance in insurance companies. However, in the revenue analysis (see Table 7), we notice that the coefficient of the government effectiveness variable is positive and statistically significant but the coefficients of the political stability and absence of violence, the regulatory quality and the institutional development variables are negative and statistically significant. These last results seem to suggest that, in general, better outcomes in political stability and absence of violence, regulatory quality and institutional development increase the gap between the country revenue frontier and the European revenue meta-frontier and, hence, decrease performance in terms of revenue efficiency. This last finding may be due to the fact that, better outcomes on these governance dimensions may result in lower insurance prices with the corresponding negative effect on revenues.[10]

The fact that better outcomes of national institutional quality increase the meta-technology cost efficiency ratio but decrease the meta-technology revenue efficiency ratio could be explained because institutional quality may affect both input prices and output prices negatively. The negative effect of institutional quality on input prices would imply that the leading insurers in cost efficiency in a country with better outcomes in institutional quality would be the leading insurers in the EU in terms of cost efficiency. However, the negative effect of institutional quality on output prices would imply that the leading insurers in revenue efficiency in a country with better outcomes in institutional quality would be far from being the leading insurers in the EU in terms of revenue efficiency. That is, these findings may be indicating a cost compensation (via lower input prices) of leading insurers in countries with better outcomes of institutional development but a revenue penalty (via lower output prices) as well.

As a robustness test of our results on the effect of both financial market development and institutional quality on the meta-technology efficiency ratios, we also estimated Models 1 to 5 of Tables 6 and 7 by including additional variables to proxy for stock market and banking sector development as well as the *bancassurance* interaction term. Results from this additional analysis are presented in Table 8 for both the cost (Models 1–5) and revenue analysis (Models 6–10). On one hand, results from Table 8 in the cost analysis confirm a positive and statistically significant relationship between better outcomes on political stability and absence of violence, regulatory quality and institutional development indicators with respect to the meta-technology cost efficiency ratio. On the other hand, results from Table 8 in the revenue analysis also confirm a negative and statistically significant relationship between better outcomes of regulatory quality and institutional development indicators and the meta-technology revenue efficiency ratio. Furthermore, we observe that the results in the cost analysis (which are presented in Table 4) with respect to the stock market development and banking

[10] In line with this reasoning, several authors provide evidence that the cost of financial intermediation for households and firms is lower in countries with better institutions (see e.g. (Demirgüç-Kunt et al., 2004; Leaven and Majnoni, 2005).

Table 7
Meta-technology revenue efficiency ratio and institutional quality.

Model	1		2		3		4		5	
Key variables										
Governance dimensions										
Political stability and absence of violence	−0.026	***								
Government effectiveness			0.031	***						
Regulatory quality					−0.032	**				
Rule of law							−0.007			
Institutional development									−0.049	***
Control variables										
Country factors										
Inflation	0.006	***	0.007	***	0.007	***	0.006	***	0.006	***
GDP per capita growth	0.001	*	0.000		0.001		0.001		0.001	
Concentration (CR5)	0.058	***	0.073	***	0.071	***	0.072	***	0.067	***
Social security size	0.007	***	0.009	***	0.008	***	0.008	***	0.008	***
Old-age dependency ratio	−0.002	***	0.000		0.000		−0.001		−0.002	**
Firm characteristics										
Size	0.098	***	0.100	***	0.100	***	0.101	***	0.100	***
Capitalization	−0.223	***	−0.218	***	−0.220	***	−0.219	***	−0.221	***
Group	0.004		0.004		0.003		0.003		0.002	
Crisis dummy	0.021	***	0.014	***	0.016	***	0.017	***	0.018	***
Country dummies	Yes		Yes		Yes		Yes		Yes	
Log likelihood	6985		6977		6976		6974		6977	
Observations	8594		8594		8594		8594		8594	

This table reports the results of estimating Eq. (1) using Tobit random-effects regression models, where the dependent variable is the meta-technology revenue efficiency ratio. The key explanatory variables are measures of institutional quality. These explanatory variables as well as the country Control variables (except the two macroeconomic variables) are defined in Table 2. Additionally, we include size (calculated as the log of assets), capitalization (calculated as equity capital to total assets) and group (equal to 1 if the decision making unit is a group of insurers) as Firm level control variables. A crisis dummy variable is also included to control for the period since the financial crisis started. Coefficients for intercept and country dummies variables are not reported. ***, ** and * mean statistical significance at 1%, 5% and 10%, respectively.

sector development variables and the *bancassurance* interaction term persist (present the same sign and are statistically significant) in this additional analysis (see Table 8, Models 1 to 5). We also notice that the results in the revenue analysis (which are presented in Table 5) with respect to the *bancassurance* interaction term persist in this additional analysis (see Table 8, Models 6 to 10).

5.3. Control variables

Focusing now on the control variables and taking into consideration both the financial market development and the institutional quality analyses, we observe that the coefficient of the concentration variable is positive and significant in 16 out of 18 regressions in the revenue analysis (see Tables 5, 7 and 8), indicating that a higher life insurance concentration level decreases the distance between the country revenue frontier and the revenue meta-frontier. This finding could be explained by two main reasons: One may be that the relatively low competition in the country where the firm is headquartered may allow the leading firms to exercise market power in setting insurance prices with the corresponding effects on revenues (see e.g. Pope and Ma, 2008). Another reason is that associated to higher level market concentration, there may be a higher level of revenue efficiency, because the former could be due to a consolidation process as a competition consequence.

Results on national macroeconomic control variables indicate that, in general, GDP per capita growth and inflation contribute positively to the performance and integration of EU life insurance markets since the coefficients are, in general, positive and significant (see Tables 4 to 8). In addition, the coefficient of the country control variable size of a country's social security is positive and significant for all the specifications in the cost analysis (see Tables 4, 6 and 8) and for most of them in the revenue analysis (see Tables 5, 7 and 8), but the coefficient of the old-age dependency ratio is always negative and significant in the cost analysis. With regard to the coefficient of the private pension variable, results show that it is negative (positive) and significant in 3 out of 4 regressions in the cost (revenue) analysis. Consequently, results seem to suggest that the higher the importance of this inter-industry competitor of the life insurance industry in a country, the higher (lower) the gap between the country cost (revenue) frontier and the European cost (revenue) meta-frontier.

Regarding the firm-level control variables, the log of total assets is included in the regression to control for firm size (see e.g. Gaganis et al., 2013). Firm size is positively related to the meta-technology cost efficiency ratio and to the meta-technology revenue efficiency ratio. Thus, our results suggest that firm size contributes to the life insurers' reference set in a country being the life insurers' reference set in the European Union and, hence, contributes to homogenizing European life insurance markets. This could be due to the fact that larger insurers tend to be more likely to gain access to economies of diversification, ameliorating market performance. These results are consistent with previous studies on insurers' performance, which show a positive relationship between size and profitability (e.g. Eling and Jia, 2019).

Table 8
Robustness check results. Meta-technology cost/revenue efficiency ratio & financial market development and institutional quality.

Model	1		2		3		4		5		6		7		8		9		10	
Key variables																				
Governance dimensions																				
Political stability and absence of violence	0.014	***									−0.009									
Government effectiveness			0.020	***									0.018							
Regulatory quality					0.037	***									−0.043	***				
Rule of law							0.002										−0.027			
Institutional development									0.042	***									−0.033	*
Financial market development																				
Stock market development	0.019	***	0.019	***	0.019	***	0.019	***	0.019	***	0.003		0.003		0.002		0.003		0.003	
Banking sector development	−0.052	***	−0.059	***	−0.057	***	−0.056	***	−0.056	***	0.010		0.010		0.014	*	0.014	*	0.013	*
Bancassurance	0.034	***	0.030	***	0.029	***	0.029	***	0.032	***	0.142	***	0.146	***	0.146	***	0.146	***	0.143	***
Control variables																				
Country factors																				
Inflation	0.009	***	0.010	***	0.009	***	0.009	***	0.010	***	0.003	**	0.003	**	0.003	**	0.003	**	0.003	**
GDP per capita growth	0.001	**	0.001	***	0.001	***	0.001	***	0.001	***	0.002	***	0.001	**	0.001	**	0.001	**	0.002	***
Concentration (CR5)	−0.007		−0.012		−0.011		−0.012	*	−0.009		0.024	*	0.028	**	0.026	*	0.027	**	0.025	*
Social security size	0.008	***	0.008	***	0.008	***	0.008	***	0.008	***	0.003	**	0.004	***	0.003	***	0.003	**	0.003	**
Old-age dependency ratio	−0.005	***	−0.006	***	−0.007	***	−0.006	***	−0.006	***	−0.001		0.000		0.001		0.000		0.000	
Firm characteristics																				
Size	0.032	***	0.032	***	0.032	***	0.032	***	0.032	***	0.094	***	0.095	***	0.094	***	0.094	***	0.094	***
Capitalization	−0.132	***	−0.133	***	−0.133	***	−0.134	***	−0.132	***	−0.228	***	−0.227	***	−0.229	***	−0.228	***	−0.229	***
Group	0.005		0.005		0.004		0.005		0.005		0.008		0.009		0.009		0.008		0.008	
Crisis dummy	0.001		0.001		0.005	**	0.003		0.002		0.021	***	0.018	***	0.017	***	0.019	***	0.020	***
Country dummies	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Log likelihood	12,400		12,395		12,400		12,390		12,399		7050		7049		7052		7050		7050	
Observations	8594		8594		8594		8594		8594		8594		8594		8594		8594		8594	

This table reports the results of estimating Eq. (1) using Tobit random-effects regression models, where the dependent variable is in models 1–5 (6–10) the meta-technology cost (revenue) efficiency ratio. The key explanatory variables are measures of national financial market development and institutional quality. The *bancassurance* variable is an interaction term that is formed by a dummy variable that takes 1 if *bancassurance* is the main life insurance distribution channel in this country and the level of banking sector development. These explanatory variables as well as the country Control variables (except the two macroeconomic variables) are defined in Table 2. Additionally, we include size (calculated as the log of assets), capitalization (calculated as equity capital to total assets) and group (equal to 1 if the decision making unit is a group of insurers) as Firm level control variables. A crisis dummy variable is also included to control for the period since the financial crisis started. Coefficients for intercept and country dummies variables are not reported. ***, ** and * mean statistical significance at 1%, 5% and 10%, respectively.

To control for capitalization we include the ratio of equity capital to total assets (see e.g. Fields et al., 2012; Eling and Schaper, 2017). The coefficient of this variable is negative and significant in both the cost and revenue analyses. These results suggest that a higher level of capitalization tends to increase the gap between the country frontier and the European meta-frontier, suggesting both a cost and a revenue penalty of the firms that consume proportionately more capital. This finding is consistent with the one by Eling and Schaper (2017) who found that some European life insurers were over-utilizing equity capital. In addition, we use a dummy variable that takes one if the decision making unit is a group of insurers and zero if it is an unaffiliated single company (see e.g. Gaganis et al., 2015). Lastly, we observe that the coefficient of the crisis dummy variable is positive and significant for all the specifications in the revenue analysis, indicating an increase in MRERs in the post-crisis period.[11]

5.4. Analysis of Eurozone countries

The introduction of the Euro in 1999 was a step taken towards an integrated European life insurance market. The adoption of a common currency increases price transparency and reduces transaction costs. These facts should increase trade and competition (see e.g. Alesina et al., 2010). Since not all the countries of our sample belong to the Eurozone, we performed the whole analysis focusing exclusively on the Eurozone countries of our sample (Austria, Belgium, France, Germany, Italy, Netherlands and Spain) in order to know if the behavior of the analyzed country variables for integration improvement of EU life insurance markets differs between the countries belonging to the Eurozone and those that do not. All results are available upon request but not reported here to save space.

[11] The finding of an increase in the MRERs in the post-crisis period is confirmed when we include year dummies instead of a crisis dummy in the analysis. These results are available upon request.

Results with respect to the multiple regression analysis conducted on the Eurozone countries confirm a positive and significant relationship between the level of stock market development and the meta-technology cost efficiency ratio. They show a positive and significant relationship between banking sector development and the meta-technology revenue efficiency ratio that seems to be reinforced in countries where "*bancassurance*" is the main life insurance distribution channel. In addition, the coefficient of the concentration ratio appears negative and significant in the cost analysis (in 10 out of 14 regressions) but positive and significant in the revenue analysis (in 9 out of 14 regressions). Interestingly, the coefficient of the crisis dummy is positive and significant for most of the specifications, not only in the revenue analysis (which was the case in the study of the 10 EU countries) but also in the cost analysis. This indicates that the technology gaps (both in cost and in revenues) in the Eurozone countries decreased in the post-crisis period compared to the pre-crisis period.

Regarding the governance dimension variables, results confirm a positive and significant relationship between better outcomes of political stability and absence of violence and, in general, institutional development with respect to the meta-technology cost efficiency ratio. In addition, they show a negative and significant relationship between superior outcomes of political stability and absence of violence and, in general, institutional development with respect to the meta-technology revenue efficiency ratio.

6. Summary and conclusions

This paper provides evidence of country factors influencing integration of ten EU life insurance markets over a seventeen-year sample period. It particularly evaluates whether (and if so, how), national financial market development and institutional quality affect the performance and integration of EU life insurance markets as well as if the role of these national factors on EU life insurance integration is different in terms of cost efficiency than in terms of revenue efficiency. As proxies of integration, we use the meta-technology cost/revenue efficiency ratios, which are calculated using the meta-frontier DEA framework. This framework involves estimating country frontiers (formed by the leading firms in a country in terms of efficiency) and an EU meta-frontier which envelops the frontiers of all countries. For each operating point, efficiency scores are calculated with respect to both the EU meta-frontier and the own-country frontier. Then, the meta-technology efficiency ratio is obtained by dividing the meta-frontier efficiency score with respect to the country efficiency score and it measures how close the country frontier is to the meta-frontier. The intuition behind the use of the meta-technology cost/revenue efficiency ratio as a measure of integration is that because financial integration is expected to promote competition and efficiency, we could expect that this would imply that the leading firms in a country in terms of efficiency would also be the leading firms in the EU in terms of efficiency. Consequently, one may assume that the higher the meta-technology cost/revenue efficiency ratio, the higher integration is. The analysis is conducted by applying the Tobit random-effects regression model since the dependent variable scores fall between zero and one and our sample consists of panel data. In addition to carrying out the whole sample analysis, we conducted an analysis focusing on the Eurozone countries of our sample. The main results of the whole sample analysis, in general, persist in the analysis of the Eurozone countries.

Our regression findings support the general hypothesis that motivates this paper. That is, we find that, in general, national financial market development as well as country institutional quality influence performance and integration of EU life insurance markets. Results also show that the effect of these national factors on the integration of EU life insurance markets may be different in terms of cost efficiency than in terms of revenue efficiency. Focusing on the analysis of the effects of financial market development, we particularly find that, regarding cost efficiency, stock market development contributes to the integration of EU life insurance markets. This finding suggests that market-based financial systems are suitable for improving cost performance and integration of EU life insurance markets. We also find that in countries where *bancassurance* is the main life insurance distribution channel, banking sector development contributes to integration concerning revenue efficiency. This result indicates that *bancassurance* architecture offers benefits for integration improvement in terms of revenue synergies.

The analysis of the effect of national institutional quality on integration of EU life insurance markets shows that, effectively, differences in institutional quality across countries explain the divergence among European life insurance markets. We find that, in general, better outcomes of institutional development in a country increase (decrease) the meta-technology cost (revenue) efficiency ratio. These findings, on one hand, indicate a positive effect of institutional development on cost performance and integration of EU life insurance markets, probably due to the fact that institutional development may reduce input prices. On the other hand, they suggest that life insurance prices are lower in countries with better institutions with the corresponding revenue penalty in leading insurers of these countries. We would also like to highlight that, at the firm level, size seems to contribute to integrating European life insurance markets. However, a higher level of capitalization tends to increase the gap between the country frontier and the European meta-frontier.

Some of the implications of this research are that regulators and policymakers should be concerned about designing programs involving the development of the stock market as well as the convergence of financial services via *bancassurance* in order to improve performance and achieve a more integrated EU life insurance market. The fact that, in general, better outcomes in national institutional quality increase the meta-technology cost efficiency ratio but decrease the meta-technology revenue efficiency ratio asks for additional research to know whether, effectively, institutional quality influences life insurance prices and consumer welfare. The analysis presented here should also stimulate future research

on country factors that influence performance and integration in the EU non-life insurance market. We may expect that, in general, it is more difficult to create a fully integrated EU market for non-life insurance than for life insurance. One reason for this expectation is that consumers of non-life insurance products usually choose to buy their insurance policies locally, based on the necessity for expert knowledge of risk exposures to create suitable insurance products as well as the necessity for after-sales services. This fact may also imply that the effect of institutional quality on the integration of EU non-life insurance markets would be different than on the integration of EU life insurance markets. We may additionally expect that the role that a country's financial market development plays in the integration of EU non-life insurance markets may differ from the role that it plays in the integration of EU life insurance markets because the non-life insurance industry is primarily a risk management industry while the life insurance industry is mainly a financial industry.

Appendix. DEA Meta-technology efficiency ratio estimations

We use the *Data Envelopment Analysis* (DEA), which is a non-parametric frontier approach (see e.g. Cooper et al., 2011), to estimate cost and revenue frontiers consisting of the most efficient firms in the reference set. Cost and revenue efficiency for each firm in the sample are measured relative to "best practice" cost and revenue frontiers, respectively. Firms on the frontiers have efficiency scores of one and firms that are not on the frontiers have efficiency scores between zero and one. In calculating efficiency using DEA, we utilize input-oriented DEA to estimate cost efficiency and output-oriented DEA to estimate revenue efficiency. This choice is based on the microeconomic theory of the firm. That is, since the objective of the firm is to maximize profits by minimizing costs and maximizing revenues, cost minimization involves choosing the optimal quantities of inputs to produce a given output vector (i.e., minimizing costs conditional on outputs) and revenue maximization involves choosing the optimal quantities of outputs conditional on the input vector (i.e., maximizing revenues conditional on inputs) (see Cummins and Weiss, 2013).

We follow a two-step procedure to estimate cost efficiency. First, we estimate the input vector that minimizes the cost by solving a linear programming problem; second, we calculate the minimum cost (cost of a fully efficient firm with the same output quantities and input prices) to the firm cost ratio to get the cost efficiency measure. To estimate revenue efficiency, we also follow a two-step procedure. First, we solve a linear programming model to estimate the output vector that maximizes revenues; second, we calculate the ratio firm revenues to maximum revenues (revenues of a fully efficient firm with the same output price vector and input vector) to get the revenue efficiency measure.

We adopt the meta-frontier approach suggested by O'Donnell et al. (2008) for estimation of the meta-frontier and group-frontier (country-frontier) efficiencies. The construction of separate country frontiers makes sense when hypothesizing the presence of heterogeneity in production possibility sets among countries. The meta-frontier envelops the frontiers of all countries. The process for estimating the meta-technology cost/revenue efficiency ratio is as follows. For each operating point, efficiency is measured both relative to the own-country frontier and to the meta-frontier. Then, a measure of how close the country frontier is to the meta-frontier is obtained by calculating the ratio of the meta-frontier efficiency to the country efficiency. This ratio is named the meta-technology efficiency ratio, which has a value between zero and one. The closer the country frontier is to the meta-frontier, the closer the meta-technology efficiency ratio would be to one (see e.g. Barros and Wanke, 2017; Cummins and Rubio-Misas, 2020).

We use a modified version of the value-added approach to measure insurance outputs, inputs and output and input prices. Most of the existing studies recognize that risk-pooling and risk-bearing services, real financial services related to insured losses and intermediation services are the three main services in creating value for insurers (see e.g. Cummins and Weiss, 2013). We use the value of real incurred benefits plus addition to reserves (see e.g. Cummins and Weiss, 2013) as a proxy for the amount of risk pooling/bearing and real insurance services provided by life insurers. The real value of invested assets gives a satisfactory proxy for the intermediation function (see Cummins and Weiss, 2013). The price of the insurance output (p_{IB}) is defined as $p_{IB} = (P - IB)/IB$ where P denotes the premiums and IB expresses the value of real incurred benefits plus addition to reserves. We utilize the ratio of net investment income to invested assets for the price of the invested assets output.

In addition, according to the valued-added approach (see Cummins and Weiss, 2013), insurers use three primary inputs: labor, material and business services, and capital. Due to data unavailability, we combine labor input and materials and the business services input to make another input category constructed from the operating expenses category. This combination is commonly used in other international insurance efficiency studies (see e.g. Fenn et al., 2008). Operating expenses include commission expenses, claims handling expenses, management expenses as well as expenses from investment management. We follow previous research (e.g. Cummins et al., 2004) and calculate the quantity of the operating expenses input by dividing operating expenses by the wage rate used as a price of this input. The other two inputs used in this study, which are standard in insurance efficiency research, are equity capital and debt capital. Equity capital is defined as the policyholders' surplus. Debt capital is defined as the sum of net loss reserves, net unearned premium reserves, other technical reserves, and other liabilities (borrowed money).

We use an index based on the wages and salaries of the industry and services for each year and country of the sample period provided by Eurostat as a proxy for the price of the operating expenses input. The price of equity capital is determined by using the 20-year rolling average of the yearly rates of total return of the country specific MSCI stock market indices. The price of debt capital is proxied by the 10-year-Treasury-Bill rates for each year and country of the sample period provided by the OECD Economic Outlook database (see e.g. Eling and Schaper, 2017). Mean values of outputs, inputs, output prices and input prices per country are shown in Table A.1.

Table A.1
Mean values per country of outputs, inputs, output prices and input prices to estimate the meta-technology cost/revenue efficiency ratio.

	Austria	Belgium	Denmark	France	Germany	Italy	Netherland	Spain	Sweden	UK
Output quantity										
Incurred benefits plus addition to reserves	169.16	147.76	295.12	734.21	382.55	648.41	921.10	214.83	354.27	1345.09
Invested assets	2376.04	1536.45	6535.46	10279.33	4373.19	4838.34	22110.97	1377.19	12858.75	20232.77
Input quantity										
Equity capital	96.34	79.90	421.95	467.04	89.34	212.73	1196.25	80.52	4516.05	914.96
Debt capital	2339.37	1515.10	6320.14	10317.11	4501.38	5033.08	22686.15	1357.17	8731.65	20444.90
Operating expenses	40.88	16.72	27.58	86.05	63.40	94.07	237.40	14.14	54.83	244.56
Output price										
Incurred benefits plus addition to reserves	1.999	2.220	1.710	0.980	2.999	2.077	1.264	1.031	1.565	1.417
Invested assets	0.039	0.033	0.033	0.035	0.041	0.026	0.037	0.040	0.032	0.033
Input price										
Equity capital	0.143	0.153	0.162	0.152	0.141	0.136	0.126	0.169	0.183	0.129
Debt capital	0.041	0.039	0.040	0.040	0.036	0.045	0.038	0.044	0.037	0.043
Operating expenses	1.217	1.328	1.258	1.249	1.203	1.230	1.263	1.363	1.351	1.383

Note: Monetary variables are expressed in constant million 2000 Euros, deflated by the country-specific consumer price indices.

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