INTEGRATION AND EFFICIENCY CONVERGENCE IN EUROPEAN LIFE INSURANCE MARKETS*

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ABSTRACT

This study examines the impact of integration on the efficiency of European Union (EU) life insurance markets for the post-deregulation period 1998-2011. To assess the effects of deregulation, we first estimate cost and revenue efficiencies by applying the metafrontier data envelopment analysis (DEA) approach, which facilitates efficiency comparisons across countries. In the second stage, we test the degree of inter-country convergence as well as cross sectional dispersion by using panel data models. Our findings show that efficiencies have converged and that the dispersion of mean efficiency scores across countries has been reduced, providing evidence of integration in the EU life insurance market. Results also show the β-convergence and σ-convergence in metatechnology efficiency ratios suggesting that technological discrepancy among the life insurance markets of major EU countries has decreased. We also find that financial market development, legal and governmental systems, as well as competitive intensity affect insurance market performance and integration.

JEL classification: G22, D24, F36

Keywords: European Life Insurance Markets, Convergence, Metafrontiers, Cost and Revenue Efficiency, Environmental Factors

Highlights

- This is the first study analysing the integration and efficiency convergence of European insurance markets
- Integration in the EU life insurance markets has taken place in recent years.
- Technological discrepancy among the life insurance markets of major EU countries has decreased over 1998-2011
- Financial market development, legal and government systems as well as competitive intensity affect insurance market performance and integration

Integration and Efficiency Convergence in European Life Insurance Markets

1. Introduction

During the past decades, dramatic steps have been taken to foster integration in European insurance markets. The deregulation of European insurance markets, particularly through the European Union's (EU) Third Generation Directives implemented in July 1994, together with the establishment of the Economic and Monetary Union and the introduction of the euro aimed at fostering integration for the provision of insurance services across the EU.

The most important provision of the Third Generation Directives was the introduction of a single EU license whereby an insurer licensed in one EU country can do business in all EU countries without obtaining additional licenses or being subject to regulations by host countries. The Directives also abolished substantive insurance supervision, freeing insurers from the regulation of prices and conditions as well as removing other regulatory impediments to competition. The main objective of the Third Generation Directives was to increase competition in European insurance markets; and the directives were expected to result in better diversification of underwriting and investment risks, enhance products and services, and increase pressure on prices and profit margins.

Conducting insurance business in a unified European market promotes both competition and efficiency. Consequently, it is expected that with the removal of cross border restrictions, differences in efficiency of insurers from different countries will be reduced. Furthermore, it is also expected that deregulation-induced competition will foster efficiency by providing incentives to managers to cut costs in order to remain profitable.

However, legal systems, language, and institutional and cultural characteristics still differ significantly across EU countries. In addition, EU countries retain the right to tax differently. Such factors may serve as entry barriers and degrade the efficiency of foreign entrants (Berger, 2007). Therefore, there is a long way to go to attain a fully integrated European insurance market (see Swiss Re 1996; Cummins and Venard, 2008).

The first objective of the present study is to gauge the cost and revenue efficiencies of firms operating in ten EU national life insurance markets and investigate the impact of integration on the dynamics of efficiency in those markets for the post-deregulation period of 14 years from 1998 to 2011. In order to asses if the EU deregulation policies have succeeded in improving the efficiency and performance of life insurance sectors, we evaluate the dynamics of efficiencies obtained by data envelopment analysis (DEA), a non-parametric frontier approach. In the frontier analysis, efficiency is measured by comparing firms to "best practice" efficient frontiers formed by the most efficient firms in the industry.

Frontier efficiency measures dominate traditional techniques of firm performance as conventional financial ratios because they summarize firm performance in a single statistic that controls for differences among firms in a sophisticated multidimensional framework that has its roots in the economic theory (Cummins and Weiss, 2013). DEA especially has the advantage of allowing us to compare insurers of different size in different countries without imposing any specific parametric functional forms. We apply the *metafrontier DEA* approach (O'Donnell, Rao, and Battese, 2008) to measure efficiency scores to facilitate efficiency comparisons across countries. The metafrontier framework implies a common frontier which envelops the frontiers of all countries and over a whole sample period considered. Thus, efficiencies measured relative to the metafrontier can be decomposed into two components: a component that measures the distance of the firm to the country-specific frontier; and a component that measures the distance between the country's frontier and the metafrontier. This approach allows us to measure the degree of homogeneity of Europe's largest life insurance markets by assessing their distance to a European metafrontier.

Considering the dynamic behavior of efficiency scores, we estimate the degree of convergence, or catch-up effect, as well as cross sectional dispersion by using panel data models. We also measure the degree of homogeneity of European life insurance markets by assessing the distance of the frontier of the country to a European metafrontier and analyzing

the dynamic behaviour of technology gaps.

As we pointed out above, despite the regulatory efforts of the European Union to attain a fully integrated European insurance market, many differences among countries continue to exist. The following inter-country characteristics are emphasized:

(1) Even though life insurance penetration has tended to increase in almost all countries (except The Netherlands and The U.K.), differences continue to exist.[1] In 1998 life insurance penetration ranged from 2.1% in Austria to 8.8 % in the U.K., and in 2011 it ranged from 2.3% in Austria to 8.08% in the U.K. (Beck et al., 2010, Cihák et al., 2012).

(2) Life market share (life premium to total premiums) augmented in almost all countries. In countries where life insurance dominated the insurance landscape in 1998 (Belgium, Denmark, France, the U.K., Italy, the Netherlands, and Sweden), this segment continued dominating in 2011, except in the Netherlands where non-life insurance dominated the insurance landscape in 2011 (CEA, 2010b, Insurance Europe, 2014).

(3) The insurers' investment portfolio to GDP ratio has risen in all countries except in the UK. However there are important differences among countries. In 1999 it ranged from 12.8% in Spain to 105% in the U.K., and in 2011 it ranged from 16.8% in Spain to 89.7% in UK (CEA, 2010c; Insurance Europe, 2014).

(4) The market share of unit-linked products as an alternative to traditional products differs significantly across the countries included in our sample (e.g., in 2011 the ratio of unit-linked premiums to total premiums ranged from 11.6% in Belgium to 41.2% in the Netherlands (Insurance Europe, 2014).

(5) Countries of our study differ in the distribution of primary life premiums by type of contract. In 2011, life premiums by individual contract represented the higher proportion of life premium in Austria (95%), Belgium (75%), Germany (85%), Spain (86%), France (90%), Italy (93%), the Netherlands (75%) and the U.K. (52%). However, in the same year (2011) in Denmark and Sweden the life premiums by individual contract represented the lower proportion of life premiums with 7% and 42% respectively (Insurance Europe, 2014).

(6) The cumulative market share held by the five largest life insurers (CR5) in each national market differs among countries. In 2011 it ranged from 49.6% in Germany to 78.1% in Austria (Insurance Europe, 2014).

(7) There are important differences in cross-border insurance competition between the countries of our study.[2] In 2007 the market share of foreign companies in total domestic life business ranged from 0.54% in France to 44.56% in the U.K. (OECD, 2013).

[1] *Insurance penetration* is defined as nominal insurance premiums divided by nominal gross domestic product (GDP) (SwissRe, 2013).

[2] Cummins et al. (2017) provide evidence of important competition differences among EU life insurance markets over the period 1999-2011.

(8) The main distribution system of life insurance products differ per country. *Bancassurance* is the main distribution channel for life insurance products in many western European countries (Austria, Belgium, France, Italy, Spain). However, the role of *bancassurance* remained limited in two large western European markets, Germany and the U.K. (CEA, 2010a).

These and other important differences raise questions about whether country environmental variables explain the degree of heterogeneity of European life insurance markets in terms of the gaps between the country's frontier and the European metafrontier. This analysis constitutes the second important objective of our study, which is to investigate characteristics of the environment for performance improvement. In doing so, in a second stage we use two important statistics derived from our methodology, the metatechnology cost/revenue efficiency ratios, and we regress them on a set of country and firm characteristics. The identification of these variables will be useful to design programs involving changes to the environment that improve performance (see O'Donnell, Rao and Battese, 2008). Hence, the aim of this objective will be looking for environmental constraints that may prevent insurers in a country from choosing from the full range of technologically feasible insurers in the metatechnology set that represents the European life metafrontier. Consequently, these environmental constraints may prevent the integration of European life insurance markets.

The country environmental variables we hypothesize to affect this aspect of the performance of the European life insurance market are: capital markets development, banking sector development, the origin of the country's legal system, and governance dimensions of the country. Also playing an important role are the level of market concentration and the insurance activity of the country where the firm is headquartered.

There is a growing body of literature on efficiency in the insurance industry (for a review, see Cummins and Weiss, 2013) including several papers analyzing the effects of deregulation on efficiency and productivity in European national markets (e. g., Cummins and Rubio-Misas 2006 for Spain; Mahlberg and Url 2010 for Germany). We extend their research by providing the first analysis of integration and efficiency convergence of European insurance

markets and one of the few studies on insurance that use the metafrontier concept. [3] This is also the first study to using the metafrontier concept for revenue efficiency and also the first to investigate country factors that influence the integration of European life insurance markets in terms of efficiency.

The remainder of the paper is organized as follows. Section 2 presents a review of the literature and formulates hypotheses to be tested. Section 3 describes the sample and defines outputs, inputs, prices and estimation methodology. The results are presented in Section 4, and Section 5 concludes.

2. Literature Review and hypotheses formulation

2.1. **Literature review**

This section starts with a review of the literature on the relationship between the EU integration and efficiency in the financial services industry. It is followed by a survey on the efficiency/productivity studies of European insurance markets in a cross-country setting as well as on the efficiency/productivity studies on European national markets covering a period after the principal steps taken to foster the integration in European insurance markets.

The empirical evidence regarding the EU integration and efficiency in the financial services industry is rather scarce. Among the very few studies available, most have been undertaken for the banking sector and usually show convergence on cost efficiency. Most of them use efficiency scores resulting from a common or pooled frontier for every year of the sample period. Mamatzakis et al. (2008) analyze banks in 10 new EU member states over the period 1998-2003 providing evidence of some convergence in cost efficiency but not in profit efficiency. Weill (2009) provides evidence of cost efficiency convergence for a sample of banks from 10 EU member countries from 1994 to 2005. Casu and Girardone (2010) analyze

[3] The other are Barros and Wanke (2017) analyzing the insurance companies from Angola and Mozambique and Wanke and Barros (2016) studying the Brazilian insurance industry. This concept has been also applied in studies on efficiency in the banking industry in a cross-country setting (e.g. Boss and Schmiedel, 2007; Kontolaimou and Tsekouras, 2010).

banks operating in 15 EU countries for the period 1997-2003. Their results show the convergence of cost efficiency towards an EU average, but they don't show an overall improvement of efficiency levels towards best practice. Matousek et al. (2015) analyse commercial banks in 15 EU countries for the period 2005-2012 showing no evidence of group convergence. [4]

There are few studies on efficiency and productivity of European insurance markets in a cross-country setting and no one studies the integration and efficiency convergence of European life insurance markets with the metafrontier concept. Diacon et al. (2002) analyze DEA technical efficiency and its components for European specialist and composite insurers transacting long-term insurance business in 15 European countries over the period 1996-1999. Their results show that pure technical efficiency has declined since 1996. Fenn et al. (2008) use stochastic frontier analysis (SFA) to estimate separate cost frontiers for life, non-life, and composite insurers from 14 major European countries for the period 1995-2001. They report that company size and domestic market share are significant factors determining X-inefficiency and large firms tend to have higher levels of cost inefficiency.

Berry-Stölzle, Weiss and Wende (2011) analyze non-life insurers in twelve European countries for the period 2003-2007 using DEA analysis. They test the structure-conduct-performance, relative market power and efficient structure hypotheses providing support to the efficient structure hypothesis. Vencappa et al. (2013) analyze the total factor productivity growth for a sample of European life and non-life insurance companies belonging to major European countries for the period 1995-2008 using SFA. Their results show that productivity change in the European insurance sectors is intrinsically volatile and is driven mainly by changes in mean technical efficiency.

In European national markets, several studies have analyzed efficiency and productivity

[4] Others studies on banking analyzing convergence in efficiency/productivity include Fung (2006) and Lozano-Vivas and Pastor (2006). However these studies did not exclusively analyze European banking.

covering a period following the deregulation introduced by the Third Generation Directives. Most of these studies show that markets experienced significant total factor productivity gains. Mahlberg and Url (2003) analyze the Austrian insurance companies over the period 1992 through 1999 providing evidence of productivity growth. Barros et al. (2005) study the efficiency and productivity of the Portuguese insurance industry over the period 1995-2001. The results show an increase in total factor productivity during the sample period. Cummins and Rubio-Misas (2006) analyze deregulation and efficiency in the Spanish insurance industry over the period 1989-1998 showing that efficiency trended upward during the sample period and that the market experienced significant total factor productivity gains.

Mahlberg and Url (2010) study the single market effects on efficiency and productivity in the German insurance industry over the period 1991 through 2006 providing evidence of productivity growth over the sample period. According to our knowledge, this is the only paper on the insurance industry that uses the literature on long-run economic growth to analyze convergence in efficiency and productivity. The results show that the dispersion of cost efficiency scores declines over time and reject β-convergence in productivity levels amongst German insurance companies. Bikker and Gorter (2011) analyze the restructuring of the Dutch non-life insurance industry from a cost efficiency perspective. They observe that the non-life insurance industry in the Netherlands has undergone fierce consolidation, increased focus, and a deteriorating market share of mutuals. The results show substantial scale economies and support both the efficient structure and the strategic focus hypotheses.

2.2. **Hypotheses formulation**

The main objective of the EU Third Generation Insurance Directives was to increase competition in European insurance markets both within and across national boundaries by removing entry barriers. The Third Generation Directives basically implied the establishment of a single EU license such that an insurer could operate in the EU by obtaining a license from only one national EU regulator rather than being licensed in each member nation. The

Directives also introduced the home country supervision principle, which means that the insurer is regulated only by the nation which issued its licence. The Directives also abolished several important areas of insurance supervision, deregulating pricing, contracting, and other insurance operations, and focusing regulation on solvency control. This set of regulatory rules was expected to transform the EU life insurance industry into a more competitive and efficient market, increasing consumer choice and reducing prices (see Swiss Re, 1996, Cummins and Rubio-Misas, 2006). Another step taken towards an integrated European life insurance market was the introduction of the euro in 1999. The creation of the single currency removed the exchange risk for insurers in cross-border acquisitions and in the supply of cross border services.

Consequently, the aim of EU insurance integration should be similar to the convergence towards the law of one price which states that all insurers should charge the same prices for similar products independently of the country where they are traded. To reach the objective of the law of one price, convergence in cost efficiency of European insurers is required because differences in insurance costs prevent insurance prices from converging (see Weill, 2009; Casu and Girardone, 2010). In addition, if insurance prices converge, we could also expect convergence in revenue efficiency.

In order to test convergence in efficiency we borrow two major concepts of convergence from the growth literature: the β-convergence and the σ-convergence proposed by Barro and Sala-i-Martin (1995) and the specification for panel data (see Canova and Marcet, 1995; Parikh and Shibata, 2004; Weill, 2009). In our context β-convergence means that countries with initial lower levels of insurance efficiency have faster growth rates than countries with higher initial levels of insurance efficiency. And σ-convergence appears if each country's level of insurance efficiency is converging to the average level of the group of countries. Therefore, it captures the speed of convergence. These arguments lead to the following hypotheses:

H1: We will observe β-convergence in cost and revenue efficiency (measured relative to the metafrontier) in European life insurance markets.

H2: We will observe σ-convergence in cost and revenue efficiency (measured relative to the metafrontier) in European life insurance markets.

Our methodology allows the efficiency measured relative to the metafrontier to be divided into a component that measures efficiency relative to the own-country frontier and a component that measures the metatechnology cost/revenue efficiency ratio, which is the reciprocal of the distance between the country frontier and the metafrontier.

If European life insurance markets have become more homogeneous over our sample period, we expect a decrease in the distances between the country frontiers and the metafrontier and consequently we expect an increase in metatechnology cost/revenue efficiency ratios as well as a decrease in the spread of these ratios. Considering the concepts of β-convergence and σ-convergence in this context, β-convergence would imply that countries with lower initial levels of metatechnology cost/revenue efficiency ratios (i.e., technologies that depart further from the technology of the metafrontier) have shown faster efficiency growth than countries with higher initial levels of metatechnology cost/revenue efficiency ratios. And σ-convergence appears if each country's level of metatechnology cost/revenue efficiency ratio is converging to the average level of the group of countries. Accordingly, we hypothesize:

H3: We will observe β-convergence in the metatechnology cost/revenue efficiency ratios in European life insurance markets.

H4: We will observe σ-convergence in the metatechnology cost/revenue efficiency ratios in European life insurance markets.

The second important objective of our study is to investigate country environmental factors affecting the metatechnology cost/revenue efficiency ratios.[5] That is, the second important goal of our study is to identify environmental characteristics conducive to

[5] As we noted above, the right to tax differently by each member country of the EU is one of the important country factors that could affect performance avoiding the integration of the European life insurance markets. Unfortunately, data availability prevents us from testing it.

performance enhancement and integration improvement. The environment variables we analyze include capital markets development, banking sector development, the origin of the country's legal system, governance dimensions of the country, and the level of concentration and the life insurance activity of the national life market where the insurer is settled. The selection variables are based on the literature on cross-country analysis of insurer performance (e.g., Pope and Ma, 2008; Fields et al., 2012; Berry-Stölzle et al., 2011) as well the literature on cross-country analysis of life insurance demand (e.g. Beck and Webb, 2003).

Higher levels of capital markets development and banking sector development within the country where the insurer is settled facilitate raising external capital and also 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 metafrontier. 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 (Levine, 1997). Capital market development is critical for life insurers because they are important institutional investors and well-developed capital markets provide more opportunities to invest efficiently and earn higher investment returns.[6] In addition, well-functioning banks may provide life insurers with an efficient payments system and increase the confidence of consumers in other financial institutions such as life insurers (Beck and Web, 2003).

The adequate protection of property rights and effective enforcement of contracts facilitate the investment function of life insurers (Beck and Web, 2003). Hence, the level of legal protection and enforcement provided to external creditors and shareholders may

[6] In 2010 life insurers managed investment of around 10% of total global investment (Swiss Re, 2012). In Europe, insurers invest the largest proportion of their portfolio in debt securities and other fixed-income assets as well as in shares and other variables-yield securities. Together these two types of assets account for more than 70% of the total (CEA, 2010a).

contribute to the performance of life insurers both within the country where the firm is domiciled and in other EU countries. European countries can be classified into four groups according to the origin of a country's legal system: English common law, French civil law, German civil law, and Scandinavian civil law. Based on this classification La Porta et al. (1998) found that common law countries provided the greatest protection of shareholder and creditor rights, while French civil law countries provided the least protection. Their results support the view that the origin of a country legal system is related to the level of legal protection and enforcement provided to external creditors and shareholders.

In addition to the legal system of a country, there could be other institutional and political factors that can affect the performance of life insurers both within the country and abroad and, hence, the integration of European life insurance markets. We consider four dimensions of governance: (1) political stability and absence of violence, (2) government effectiveness, (3) regulatory quality, and (4) rule of law (see Kaufmann, Kraay and Mastruzzi, 2009). These governance indicators are measured in units ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes. Firstly, we can think that the lack of these four 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 Web, 2003) and consequently may affect performance negatively. However, given the 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 return as well (see Fields et al., 2012).

European life insurers markets differ considerably in terms of insurance penetration levels as well as in terms of concentration, where penetration is defined as the ratio of premiums to GDP. In 2011, life insurance penetration ranged from 2.3 % in Austria to 8.08% in the UK and the cumulative market share held by the first five life insurers ranged from 49.6% in

Germany to 78.1% in Austria. Life insurance penetration provides information about the level of activity as well as the saturation of the market. Growth is expected to be easier in markets with lower penetration rates than in markets with higher penetration rates, where growth is possible only at the expense of other firms' market share (see Berry-Stölzle et al., 2013). Based on this reasoning, we expect that firms headquartered in countries with higher penetration rates could use lower output prices to gain market share and consequently their country revenue frontier would be comparatively far away from the European metafrontier.

Higher market concentration ratios are traditionally associated with relatively low market competition. In addition, prior research suggests that at higher levels of market liberalization (which is the case of the EU-15 countries) the relationship by market concentration and performance is negative (Pope and Ma, 2008). Consequently, we could expect a higher level of national market concentration to influence negatively in the performance of European life insurance markets by increasing the gap between the country frontier and the European metafrontier.

These arguments could be formalized in the following general hypothesis:

> **H5:** Environmental factors affect metatechnology cost/revenue efficiency ratios and consequently the performance and integration of European life insurance markets.

The expected direction of the relationship between the country environmental factors and efficiency has been discussed in this section.

3. Data and Methodology

3.1. Data sources

Our sample consists of an unbalanced panel of life insurers from 10 EU countries spanning a 14-year-period from 1998 to 2011. The 10 countries were selected based upon the length of time they have been in the EU and also on considerations of data availability. [7] Annual

[7] These 10 EU countries are Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, and the U.K. We first considered the countries that were in the EU during all the years of the period of analysis. That is, the EU-15, therefore, we excluded countries which joined in the so-called Fifth Enlargement-part I (in

financial statements were obtained from the Orbis Insurance Focus dataset provided by Bureau van Dijk to construct the relevant variables of interest.[8] For each insurer, 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. Consolidated data are used for groups of insurers and unconsolidated data for unaffiliated single insurance companies. Unaffiliated insurers are associated to the country where they are domiciled. Group of insurers are linked to the country where the group is domiciled, although subsidiaries domiciled in different countries from the group may belong to a group. All monetary variables are expressed in millions of euros and deflated by the country-specific Consumer Price Index (CPI) to the base year 2000. Country-specific CPIs are obtained from the International Labor Organization (ILO).

The final sample is a result of a series of screening tests. We eliminated non-viable firms such as firms with non-positive incurred losses, invested assets, equity capital, total debt, net premiums or operating expenses. The final sample includes a total of 7,062 year-firm observations.

The country level data were obtained from a variety of sources. Information on capital markets development, banking sector development, and life insurance penetration 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 (Kaufman et al., 2009). 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

2004) and in the so-called Fifth Enlargement-part II (in 2007). Furthermore, we excluded Finland, Greece, Ireland, Luxembourg, and Portugal due to the lack of homogeneous data to construct the relevant variables, the limited number of firms per year in some countries and because in some years and countries we did not have any firms after considering the screening tests.

[8] Orbis Insurance Focus dataset provided by Bureau van Dijk was formerly known as ISIS database.

and inflation rates from the Eurostat database.

3.2. Outputs, inputs, and prices

In line with most studies of efficiency in insurance, we use a modified version of the value-added approach to measure insurance outputs and inputs (e.g. Cummins, Weiss and Zi, 1999; Berger et al. 2000). 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 (Cummins and Weiss, 2013).

A satisfactory proxy for the amount of risk pooling/bearing and real insurance services provided is the value of real losses incurred (see Cummins, Rubio-Misas and Zi, 2004; Cummins et al., 2010) defined as gross claims minus reinsurer's share plus addition to movements in insurance funds (reserves). The output variable which proxies for the intermediation function is the real value of invested assets, the value of assets under management (Cummins et al., 2009). Life insurers provide savings and retirement vehicles, so they provide the intermediation function to a higher degree than non-life insurers.

The price of the insurance output is defined as p_{LI}= (P- LI)/LI where p_{LI}= the price of the value of real losses incurred output; P= Premium; and LI= the value of real losses incurred. For the price of the invested assets output, we utilize the ratio of net investment income to invested assets.

According to the valued-added approach, insurers use three primary inputs: labour, material and business services, and capital (see Cummins et al., 2009). Due to data availability, we combine labor input and materials and business services input to make another input category, the operating expenses category. This input includes claims handling expenses, commission expenses, management expenses as well as expenses from investment management. This definition is commonly used in other international insurance efficiency studies (see Fenn et al., 2008, Eling and Luhnen, 2010). The other two inputs used in this study, which are standard in insurance efficiency research, are debt capital and equity capital. Debt

capital is defined as the sum of net loss reserves, net unearned premium reserves, other technical reserves, and total other liabilities (borrowed money). Equity capital is defined as the policyholders' surplus.

As a proxy for the price of the operating expenses input 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. The price of debt capital is proxied by using the 10-year-Treasury-Bill rates for each year and country of the sample period provided by the OECD Economic Outlook database. The price of equity capital is determined by using the 20-year average of the yearly rates of total return of the country specific MSCI stock market indices (see Eling and Luhnen, 2010).

3.3. Methodology

3.3.1. Efficiency methodology: Data Envelopment Analysis (DEA)

We measure cost and revenue efficiency for each firm in the sample relative to "best practice" cost and revenue frontiers, respectively, consisting of the most efficient firms in the industry. Firms on the frontiers have efficiency scores of 1 and firms not on the frontiers have efficiency scores between zero and 1.

The two primary approaches for estimating efficient frontiers are stochastic frontier analysis (SFA) using econometric methods and mathematical programming. Both methodologies have strengths and limitations. The econometric approach requires the specification of a functional form for the cost and revenue equation as well as assumptions about the properties of the composed error term, which consists of an inefficiency component and a purely random component. Thus, the econometric approach facilitates the separation of departures from the frontier into inefficiency and purely random error. However, incorrect assumptions about the functional form or the error term can lead to specification error, with unknown effects on the results.

The alternative to SFA is mathematical programming, and the mathematical

programming approach used most frequently in the literature is *data envelopment analysis* (DEA) (see Cooper, Seiford and Tone 2007). DEA has the advantage of not requiring assumptions about functional form or the properties of a random error term. Rather, efficiency is measured for each firm by constructing dominating or reference sets of efficient firms in the industry.

Theoretical research has shown that the DEA approach possesses good asymptotic statistical properties. DEA has been shown to be equivalent to maximum likelihood estimation, with the specification of the production frontier in DEA as a nonparametric monotone and concave function instead of a parametric form as in the econometric case (Banker 1993; Korostelev, Simar, and Tsybakov 1995). DEA estimators also are consistent and converge faster than estimators from other frontier methods (Kneip, et al. 1998; Korostelev, Simar, and Tsybakov 1995). DEA also has been shown to perform well in empirical analyses. For instance, a simulation study suggests that DEA provides more accurate efficiency estimates than the econometric approach in the presence of econometric problems such as heteroskedasticity (Banker, Chang, and Cooper 2004).[9] Banker and Natarajan (2008) show that DEA is a non-parametric stochastic frontier estimation methodology that performs better than parametric procedures in estimating efficiency of individual decision-making units.

After estimating efficiency, we utilize ex post regression analysis. This approach is supported by theoretical work by Banker and Natarajan (2008). They show that the two-stage approach utilized in many DEA applications, where DEA efficiency estimates are regressed on firm characteristics and other covariates, yields consistent estimates of the impact of these contextual variables on efficiency. Moreover, they show that the two-stage approach is consistent in a composed error framework, i.e., that DEA like SFA incorporates one and two-

[9] In a study of the U.S. life insurance industry, Cummins and Zi (1998) found that DEA scores had higher correlations with conventional performance measures such as return on equity than scores estimated using a wide range of econometric models.

sided random errors.

3.3.2. The metafrontier and group (country) frontiers

In estimating efficiency using DEA, it is necessary to adopt an orientation. In this paper, we utilize input-oriented DEA to estimate cost efficiency and output-oriented DEA to estimate revenue efficiency (see, Cummins et al., 2010). The choice of input versus output orientation for our efficiency analysis is based on the microeconomic theory of the firm. In microeconomic theory, 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 inputs 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).

This paper adopts the metafrontier approach suggested by O'Donnell, Rao and Battese (2008) for estimation of metafrontier and group-frontier efficiencies. Suppose producers use input vector $x = (x_1, x_2, ..., x_L)' \in R_+^L$ to produce output vector $y = (y_1, y_2, ..., y_M)' \in R_+^M$, where L is the number of inputs and M is the number of outputs. The metatechnology set contains all input-output combinations that are technologically feasible and can be represented as:

$$T = \{(x, y) : x \geq 0, y \geq 0; \; x \; can \; produce \; y\}. \tag{1}$$

We assume that T is convex and satisfies some common properties of production technologies. The input set associated with this metatechnology set is defined as:

$$V(y) = \{x : (x, y) \in T\} \subseteq R_+^L \tag{2}$$

This set is assumed to satisfying the standard regularity conditions in Fare and Primont (1995). We refer to the boundary of this input set as the input metafrontier. The input-oriented metadistance function associated with this input metafrontier is given by:

$$D(x, y) = \sup\{\theta > 0 : \frac{x}{\theta} \in V(y)\}. \tag{3}$$

This distance function gives the smallest amount by which a producer can radially contract its input vector, given an output vector. $D(x, y)$ is interpreted intuitively as the distance of a given firm's input-output vector (x, y) from the metafrontier. The operating points of fully efficient firms, $D(x, y) = 1$, lie on the metafrontier, indicating that they operate with the minimum amount of inputs needed to produce their quantity of output. Inefficient firms, with $D(x, y) \geq 1$, indicate that they could reduce their input consumption while producing the same quantity of output if they operated on the metafrontier.

In the output-oriented case, technology is modeled by an output correspondence $x \rightarrow P(x) \subseteq \Re_+^M$, such that P(x) denotes the subset of all output vectors obtainable from input vector $x \in \Re_+^L$. The output distance function for a DMU maximizes output conditional on inputs is given by:

$$D_0(y, x) = \inf\{\theta : \frac{y}{\theta} \in P(x)\} \qquad (4)$$

The input distance function is the reciprocal of the minimum equi-proportional contraction of the input vector x, given outputs y, i.e., input-oriented technical efficiency $\mathrm{TE_I(y,x)=1/D_I(y,x)}$, and a similar interpretation applies for output-oriented efficiency.

By explicitly modeling the economic objective of cost minimization, we can estimate the cost efficiency of each firm with respect to the metafrontier. When the economic objective is to minimize the costs of producing a given output vector, then economic cost efficiency is measured by the ratio of minimum possible cost to actual observed cost. If producers face input prices $w = (w_1, w_2, ..., w_L)' \in R_{++}^L$, the minimum cost metafrontier is defined using the distance function approach as:

$$c(x, y) = \min_x \{w'x : D(x, y) \geq 1\}. \qquad (5)$$

The optimal input vector x^* minimizes the costs of producing *y* given the input prices *w*. Metafrontier cost efficiency then is simply defined as $CE(x, y) = w'x^* / w'x$.

The universe of producers can be divided into K groups (in our case K countries). Then the country-specific technology and input sets can be represented respectively by:

$$T^k = \{(x, y) : x \geq 0, y \geq 0; \textit{ x can be used by country k firms to produce y}\}. \quad (6)$$

$$V^k(y) = \{x : (x, y) \in T^k\} \subseteq R_+^L, k = 1,2,...,K. \quad (7)$$

We can also define country-specific input distance function and cost frontier with respect to this country-specific technology and input set and obtaining the optimal input vector x^{*k} that minimizes the costs of producing *y* given the input prices w^k. Country cost efficiency is defined as

$$CE^k(x, y) = \frac{w^{k\prime} x^{*k}}{w^{k\prime} x^k} \quad (8)$$

A measure of how close the country k cost frontier is to the cost metafrontier can also be obtained by calculating the ratio of the metafrontier cost efficiency to the country cost efficiency. We named this ratio the metatechnology cost efficiency ratio (henceforth MCER) which has a value between zero and 1. As much closer country k cost frontier is to the metafrontier the metatechnology cost efficiency ratio would be closer to 1. MCER means that given the output vector, the minimum costs that could be attained by a firm from the k country is a (1-MCER)% more than the costs which is feasible under the cost metafrontier.

We illustrate this analysis in Figure 1 for an economy where each firm uses two inputs (X_1 and X_2) with input prices (W_1 and W_2) to produce a single output (Y). The convex production frontier 1-1' is the isoquant obtained from country 1's data, the convex frontier 2-2' is the isoquant obtained from country 2's data, and so on. Thus 1-1', 2-2', and 3-3' are all country-specific frontiers. The isoquant represents the best production technology for the respective country, i.e., firms operating on the isoquant are on the production frontier and are fully technical efficient. The convex frontier, M-M', which envelops all those country-specific

frontiers is called metafrontier. In Figure 1, the metafrontier M-M' is a convex combination of country-specific frontiers 1-1' and 3-3', and the frontier 2-2' is not a part of the metafrontier (so 2-2' is not tangent to M-M').

Denote W_1-W_2 and W'_1-W'_2 as the price lines tangent (i.e., the isocost lines) to production frontiers M-M' and 2-2', respectively. Then the country-specific cost efficiency for a firm operating at point A belonging to country 2 is obtained by the ratio of OB/OA, and the metafrontier cost efficiency for the same firm is obtained by the ratio of OC/OA . Since OC/OA is less than OB/OA in Figure 1, the ratio of the metafrontier cost efficiency to the country-specific cost efficiency, OC/OB, is also less than 1. This ratio (OC/OB) is a measure of how close the country 2 cost frontier is to the cost metafrontier for the firm operating at point A. We call this ratio the metatechnology cost efficiency ratio (MCER) and it seems clear that, given that the metafrontier envelops the country-specific frontier, it has to be less than or equal to 1. The closer a country-specific frontier is to the metafrontier, the closer is MCER to 1.

In addition to studying cost efficiency, we analyze revenue efficiency. Revenue maximization involves choosing the optimal amounts and combinations of outputs conditional on the imput vector. Hence revenue efficiency provides complementary information to the analysis of cost efficiency because the only way to tell whether policies taken in the EU for integration have met with ultimate success is to measure its effects on revenue or profit efficiency (Cummins and Weiss, 2013). The analysis with respect to revenue efficiency is directly analogous to the cost efficiency case and thus is not presented in detail. The primary differences are that it adopts an output-oriented approach to maximize revenues and that the optimal operating points would be determined by the tangency of iso-output-price lines and production possibilities curves (Lovell, 1993). Revenue efficiency is defined as the ratio of the revenues of a given firm to the revenues of a fully efficient firm with the same input vector and output prices. We measure revenue efficiency of a given firm with respect to the metafrontier

as well as its revenue efficiency with respect to the country-specific frontier. The firm's metatechnology revenue efficiency ratio (MRER) is obtained as the ratio of the metafrontier revenue efficiency to the country revenue efficiency.

3.3.3. Models for Cost/Revenue Efficiency and MCER/MRER Convergence

To investigate the convergence of metafrontier cost/revenue efficiency as well as the convergence of MCERs/MRERs in life insurance markets across the EU countries and over the sample period, we utilize the two well-known concepts of convergence, β-convergence and σ-convergence proposed by Barro and Sala-I-Martin (1995).

To perform the β-convergence test, we employ the following model, which is similar to the specification for panel data from Canova and Marcet (1995) and Weill (2009):

$$\Delta V_{i,t} = \alpha + \beta \ln V_{i,t-1} + \gamma \Delta V_{i,t-1} + \sum_{i=1}^{I} \delta_i D_i + \varepsilon_{i,t} \qquad (9)$$

where $V_{i,t}$ is the mean metafrontier cost/revenue efficiency of the life insurance industry of country i at year t; $V_{i,t-1}$ is the mean metafrontier cost/revenue efficiency of the life insurance industry of country i at year t-1; $\Delta V_{i,t} = \ln(V_{i,t}) - \ln(V_{i,t-1})$; D_i country dummies; α, β, γ, δ are parameters to be estimated; $\varepsilon_{i,t}$ is the error term; i=1,2,..., I and t=1,2,..T. The equation is estimated with and without the lagged dependent variable $\Delta V_{i,t-1}$.The parameter β captures the catch-up effect and a negative value of β implies convergence.

To estimate the cross sectional dispersion or σ-convergence we use the following model used in Parikh and Shibata (2004) and Weill (2009):

$$\Delta W_{i,t} = \alpha + \sigma W_{i,t-1} + \rho \Delta W_{i,t-1} + \sum_{i=1}^{I} \delta_i D_i + \varepsilon_{i,t} \qquad (10)$$

where $W_{i,t} = \ln(V_{i,t}) - \ln(\overline{V}_t)$; $W_{i,t-1} = \ln(V_{i,t-1}) - \ln(\overline{V}_{t-1})$; $\Delta W_{i,t} = W_{i,t} - W_{i,t-1}$; $V_{i,t}$, $V_{i,t-1}$, D_i are defined as before; $\overline{V}_t$ and $\overline{V}_{t-1}$ are the mean metafrontier cost/revenue efficiencies of the EU

life insurance industries used in this study at year t and t-1, respectively; $\alpha, \varsigma, \gamma, \delta$ are parameters to be estimated; $\varepsilon_{i,t}$ is the error term; i=1,2,..., I and t=1,2,..T. The equation is also estimated with and without the lagged dependent variable $\Delta W_{i,t-1}$. The negative value of the coefficient σ captures the rate of convergence of $V_{i,t}$ torward the EU average cost/revenue efficiency. The larger the absolute value of σ, the faster the rate of convergence. We also evaluate the two convergence equations for metatechnology cost/revenue efficiency ratios.

4. Results and discussion

This section presents and discusses our empirical results. Summary statistics on inputs, outputs, prices, efficiency scores, and metatechnology efficiency ratios as well as convergence test results are presented first. The multiple regression analysis is then discussed.

4.1. Efficiency results and convergence tests.

Summary statistics on outputs, inputs, and prices are shown in Table 1. The table presents averages for all the years of the sample period (1998-2011) as well as the average annual growth rate from 1998 to 2011. Average market output increased significantly over the sample period. Average invested assets grew by 9.8% per year and average losses incurred by 9% per year. A first indicator of improved market efficiency due to competition is that total input usage generally increased by smaller percentages than output except average debt capital that increased by higher percentage than output. In general, output and input prices decreased over the sample period, except the operating expenses input price that grew by 2.4% per year.

The yearly average cost efficiency results in life insurance for the countries in our sample are presented in Table 2.[10] The results are shown for cost efficiencies measured relative to metafrontier as well as to country-specific frontiers. The metatechnology cost efficiency ratios also are shown.

[10] Efficiency scores are calculated using Frontier Efficiency Analysis with R (see Wilson, 2008).

The average metafrontier cost efficiency scores for the 10 EU life insurance markets over the whole sample period is 0.612, indicating a 38.8% potential reduction in cost on average. The results for the different EU countries show discrepancies in the cost efficiency in the life insurance markets. In 1998, the metafrontier cost efficiency averages range from 0.387 in Sweden to 0.719 in Germany, while they range from 0.491 in Sweden to 0.762 in Denmark in 2011. This finding suggests that, even if cross-country differences in EU life insurance efficiency remain substantial in 2011, they have decreased slightly over the period.

We also observe an increase in the average metafrontier cost efficiency for the 10 EU life insurance industries as a whole, and also in 8 out of 10 countries of our sample. The above results confirm that cost efficiencies measured relative to the metafrontier increased over the sample period, providing certain evidence that European integration had a positive impact on the cost efficiency of European life insurance markets.

The MCERs for the 10 European life insurance markets are shown in Panel C of Table 2. MCERs allow us to evaluate the closeness of country cost frontiers to the cost metafrontier. The average MCER for the 10 EU life insurance industries over the sample period is 0.916, which is closer to 1, indicating that in general the country-specific cost frontiers are close to the European life cost metafrontier. Sweden is the country that shows on average the biggest technology gap (0.733) while the U.K. (0.968), Germany (0.967), and Spain (0.905) show lower technology gaps between country-specific life cost frontier and the European life cost metafrontier. We also observe an increase in the average MCERs for the 10 European countries as a whole, and also in 5 out of 10 countries of our sample. In addition, the standard deviation of the MCERs (not shown in tables) decreased over the sample period for the 10 EU life insurance industries as a whole and for 6 out of 10 countries. These findings provide some evidence that the technological discrepancy among the life insurance markets of major EU countries has decreased over the sample period.

The average revenue efficiency results in life insurance for all 10 EU countries of our

sample are presented in Table 3. Panel A shows metafrontier revenue efficiency scores, Panel B country-specific revenue efficiency scores, and Panel C MRERs. The average metafrontier revenue efficiency scores for the 10 EU life insurance industries over the sample period is 0.236 indicating a 76.4% potential increase in revenues on average. This figure is considerably low relative to cost efficiency (0.612), indicating that on average EU life insurers are more cost efficient than revenue efficient. The results for the different EU countries show lower discrepancies in metafrontier revenue efficiency than in metafrontier cost efficiency. An increase in the overall metafrontier revenue efficiency in life insurance is observed for the 10 EU countries as a whole as well as in 10 out of 10 EU countries of our sample. Accordingly, these results provide certain evidence that also on the revenue efficiency of European life insurers did the European integration have a positive impact for European life insurers during the sample period.

The average overall MRERs for the life insurance markets over the sample period is 0.560, indicating than in general the life country revenue frontiers are more distant from the life EU revenue metafrontier than are the life country cost frontiers from the EU life cost metafrontier. Austria is the country that shows on average the biggest technology gap (0.105) while Germany (0.878), the UK (0.561), and Italy (0.408) show lower technology gaps between the country-specific revenue frontier and the European revenue metafrontier. An increase in MRERs in 10 out of 10 EU countries in life insurance is observed over the sample period and also for all European countries of the sample as a whole. We analyze the dispersion of life MRERs from the average values over the sample period and find that standard deviation (not shown in tables) slightly decreased for all sample as a whole but increase in 9 out of 10 countries, suggesting that maybe technological discrepancy in revenues among the life insurance markets of major EU countries has not decreased over the sample period.

In a second stage we evaluate β-convergence and σ-convergence for the metafrontier cost efficiency scores as well as for the metafrontier revenue efficiency scores by estimating

equations (9) and (10). We estimate these two equations with and without the lagged dependent variable. The results of the β and the σ-significance tests for the metafrontier cost efficiency scores in EU life insurance are displayed in panel A of Table 4, while the results of the same tests for the metafrontier revenue efficiency scores in EU life insurance are displayed in panel A of Table 5.

The results provide evidence for β-convergence in metafrontier efficiency both in costs and revenues. The coefficient β is negative and significant in all tests. These results confirm that the least cost/revenue efficient countries in 1998 have shown a higher improvement in efficiency than the most efficient countries in 1998. Thus these results provide evidence of efficiency catch-up among the 10 EU insurance markets.

The results from all the estimations of the σ-convergence in the metafrontier efficiency scores (both in cost and in revenues) suggest that the dispersion of the mean efficiency scores among EU countries decreased during the sample period as the σ coefficient is always negative and statistically significant.

The results for the β-convergence and the σ-convergence for the metatechnology cost efficiency ratios and metatechnology revenue efficiency ratios in the EU life insurance industry are presented in panel B of Table 4 and panel B of Table 5, respectively. Our results provide evidence for β-convergence in MCERs as well as in MRERs in the life insurance segment. These results suggest that the countries having that the biggest technology gap in 1988 with respect to the cost/revenue metafrontier have shown a higher improvement in their technology than the countries having the lowest technology gap in the same year.

Our results also provide evidence of σ-convergence in MCERs as well as in MRERs. These results confirm that both the dispersion of the mean MCERs as well as the dispersion of the mean MRERs among EU countries decreased during the sample period. The absolute value of the σ is slightly larger in the metatechnology cost efficiency analysis than in the metatechnology revenue efficiency analysis, suggesting faster rate of technology convergence

in cost than in revenues in the EU life insurance markets during the sample period.[11]

4.2. Multiple regression analysis.

To provide evidence on country environmental factors that influence performance of EU life insurance markets, we conduct multiple regression analysis with metatechnology cost/revenue efficiency ratios as dependent variables. We use Tobit regression models as metatechnology cost/revenue efficiency ratios scores fall between 0 and 1, thus making the dependent variable a limited dependent variable. The independent variables are country environmental characteristics, allowing tests of hypothesis H5 as well as firm level control variables that measure the financial and operating characteristics of the firms in the industry. The firm characteristic variables include size, capitalization, the use of reinsurance and ownership type in addition of other country level control variables.

We also include two control variables for the main macroeconomic conditions under which the life insurers of each country are operating: the inflation rate and GDP growth. Year dummies variables are also included in the regression analysis. A positive coefficient on the independent variable would imply that higher levels in this variable increase the metatechnology 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 metafrontier. Negative coefficients would convey the opposite implication.

The definitions and data sources of country variables included in the regression analysis to test hypothesis 3 are shown in table 6. Table 7 reports the descriptive statistics for the

[11] We tested whether our results on convergence are robust over the sample period or affected for the period since the financial crisis started (results of these robustness tests are available from the authors upon request). In doing so, we conducted two additional analyses: (i) we include in the regressions a crisis dummy variable (1 for the years of the period 2008-2011) as well as its interaction with the main explanatory variable. Results show that the coefficients signs and the level of significant of the main regression variables remain unchanged (β and σ were negative and statistically significant at 1% both in the cost analyses and in the revenue analyses). However, their interactive terms with the crisis dummy as well as the crisis dummy were all insignificant; and (ii) we did separate analyses for the periods 1998-2007 and 2008-2011 on convergence tests. For both periods, the β and σ coefficients were negative and statistically significant at 1% both in the cost analyses and in the revenue analyses. Consequently, the main results of the existence of β-convergence and σ-convergence over the period 1998-2011 both in the cost analyses and in the revenue analysis prevails when applying the previous robustness tests.

variables included in the regression analysis.

The regression results are presented in Tables 8. We present results from 5 different models: model 1 does not incorporate any governance dimension variables; models 2 to 5 include only 1 governance dimension variable. That is, as those measures are correlated, they are included one by one.

Because security markets incorporate both stock and debt markets, we use two variables to measure the level of capital market development in a country: (1) The stock turnover ratio, which measures the activity or liquidity of the stock market relative to its size, (see 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 public bond market capitalization to GDP since European life insurers invest more in the public bond market than in the private bond market.[12]

All regression models show a positive and significant relationship between the level of stock market development and the metatechnology efficiency ratio (both cost and revenue). This provides evidence that the higher the liquidity of the stock market of the country where the firm is headquartered, the lower is the gap between the country frontier and the European metafrontier. The results also show a positive and significant relationship between the size of the debt market and the metatechnology efficiency ratio (both cost and revenue).

The level of the banking sector development is proxied by the private credit by deposit money in bank and other financial institutions to GDP (see Beck and Webb, 2003; Arena, 2008). This variable is positive and significant in all regressions in the cost analysis and in regressions in the revenue analysis, providing evidence that higher banking sector development

[12] We conducted an additional analysis by including the size of the debt market variable (public bond market capitalization plus private bond market capitalization) to GDP instead of the size of the public debt market to GDP in the regression analysis as a measure of debt market development. The results of this additional analysis (available from the authors upon request) show the same sign and significance for the coefficient of all the variables except for the banking sector development variable that is not significant in 4 out of 5 regressions in the cost analysis and in 2 out of 5 regressions in the revenue analysis. There is an additional exception but now in the revenue analysis where the German civil law variable was not significant in 2 out of 5 regressions.

of the country where the firm is settled improves performance and integration of the EU life insurance markets. This finding could also be especially explained because in many western European countries there is a special link between life insurance and banking through the *bancasurance* phenomenon.

Dummy variables are used to represent the origin of a country's legal system (see La Porta et al., 1998). We include 3 dummy variables in the regression analysis: one for French civil law countries (Belgium, France, Italy, Netherlands and Spain in this study); another for German civil law countries (Austria and Germany in this study); and another for Scandinavian civil law countries (Denmark and Sweden in this study). The omitted variable is English common law countries. The coefficients of these three dummy variables are always negative and significant in the cost analysis providing evidence, as expected, that the common law legal system provides the greatest contribution to decrease the distance between the country cost frontiers and the European metafrontier. In other words, firms defining the country cost frontier which are located in a country with a common law system are more likely to define the European cost metafrontier. These results support the hypothesis that the greater protection of shareholder and creditor rights provided by the English common law system contributes to the performance of European life insurers. However, in the revenue analysis, while the coefficients of the French and Scandinavian dummy variables are negative and statistically significant, the coefficient of the German dummy variable is always positive and significant. These results indicate (taking into account in the analysis the explained results in footnote 12) that in the revenue analysis the English common law system did not provides more contribution than the German civil law system to decrease the distance between the country revenue frontier and the European revenue metafrontier.

Regarding governance dimensions of the country where the firm is headquartered, the political stability and absence of violence and governance effectiveness scores are negative and significant at 1% level both in the cost and in the revenue analyses. The coefficient of the rule

of law variable is also negative and significant at 1% in the revenue efficiency analysis and negative and significant at 5% level in the cost analysis. These results suggest that better outcomes on political stability and absence of violence, governance effectiveness and rule of law increase the gap between the country frontier and the European metafrontier and, hence, decrease performance. These results are consistent with the Fields et al. (2012) results that find certain evidence that a better operating environment decreases performance of insurance companies. The other variable measuring the regulatory quality is not statistically significant.

The coefficient of the life insurance penetration variable is always negative and significant in the metatechnology revenue efficiency regression analysis and in 4 out of 5 regressions of the metatechnology cost efficiency analysis, providing evidence that a higher level of life insurance activity in the country where the firm is settled prevent the leading firms in the country from being the leading firms in the EU in terms of both cost and revenue efficiency, acting as an environmental constraint. The coefficient of the concentration variable is always negative and significant, both in the cost analysis and in the revenue analysis, indicating that a higher life insurance concentration level increases the distance between the country frontier and the metafrontier. This suggests, as expected, that relatively low competition in the country where the firm is headquartered prevents the leading firm in a country from being the leading firm in the EU, in terms of both cost and revenue efficiency.

Results on the country macroeconomic variables indicate that inflation contribute negatively to the performance and integration of the EU life insurance markets since the coefficient is negative and significant both in the cost and revenue efficiency analyses.

With regard to the firm characteristics control variables, the log of total assets is included on the regression to control for firm size. Firm size is positively related to the metatechnology cost efficiency ratio and to the metatechnology revenue efficiency ratio. Thus, our results suggest that firm size contributes to the life insurers reference set in a country to be the life insurers reference set in the European Union and, hence, contribute 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.

To control for capitalization we include the ratio of equity capital to total assets. The coefficient of this variable is negative and significant in the cost analysis but positive and significant in the revenue analysis. These results suggest that a higher level of capitalization tends to increase the gap between the country cost frontier and the European cost metafrontier, but to reduce the gap between the country revenue frontier and the European revenue metafrontier, suggesting a cost penalty of the firms that consume proportionately more capital but a revenue compensation of firms that proportionately consume more capital. The cost effect reflects the cost of using additional capital, and the revenue effect likely indicates that buyers will pay higher premiums to firms with lower insolvency risk.

The use of reinsurance is also included as a firm control variable.[13] We control for this through the ratio of ceded premiums to gross premiums. The coefficient of this variable is always positive and significant in the cost analysis but negative and significant in the revenue analysis. These results suggest that the cost of reinsurance for an insurer can be much larger than the actuarial price of the risk transferred (see Cummins et al., 2008) and, consequently, reinsurance activities may increase the gap between the country cost frontier and the European cost metafrontier. However, the purchase of reinsurance reduces an insurer's insolvency risk and can have a positive effect on the revenue technology gap.

In addition we use a dummy variable that takes 1 if the decision making unit is a group of insurers and 0 if it is an unaffiliated single company. Results show a negative and significant relationship between this variable and the metatechnology cost efficiency ratio. This finding is consistent with the hypothesis that groups are likely to incur in higher agency and management

[13] Since there is not information on reinsurance utilization for some observations, including the use of reinsurance variable in the analysis reduce the sample to 6792 observations. Nevertheless, conducting the analysis without the reinsurance utilization variable (with 7062 observations) provide similar results for the other variables.

control costs than unaffiliated single companies. However this variable is positive and statistically significant in the revenue efficiency analysis indicating a revenue compensation for being a group.

To sum up, the results from the cost analysis show that higher levels of stock and debt market development, in addition to being headquartered in a country whose origin of the country legal system is common law, being an unaffiliated single company as well as the size, contribute to decreasing the gap between the country cost frontier and the European cost metaforntier. And hence, these country and firm variables contribute to performance improvement and homogenizing the EU life insurance industries in terms of cost efficiency. However, higher levels of concentration and insurance activity within the national life insurance market as well as higher levels of firm capitalization contribute to increasing this gap.

Regarding the revenue analysis, our results show that higher levels of stock market liquidity and debt market development as well as the firm's size, capitalization and being a group contribute to decreasing the gap between the country revenue frontier and the European revenue metafrontier. However, higher levels of the country life insurance penetration, higher national market concentration ratios as well as the use of reinsurance contribute to increasing this gap. Finally, our results show that better governance outcomes on political stability and absence of violence, governance effectiveness and rule of law contribute to increasing the gap between the country frontier and the European metafrontier and consequently decrease performance in terms of both cost and revenue efficiency.

5. Conclusions

This paper provides evidence on the dynamics of cost and revenue efficiency in 10 EU life insurance markets during the period 1998-2011 in order to evaluate the impact of EU life insurance integration. Efficiencies are calculated using the metafrontier DEA approach to make efficiency comparisons across countries. The yearly results seem to indicate an increase in the

overall metafrontier cost efficiency for the 10 EU countries as a whole as well as in the overall metafrontier revenue efficiency. Results also show an increase in the overall metatechnology efficiency ratios in both the cost analysis and the revenue analysis, indicating a decrease in technology gaps between country frontiers and the European metafrontier. UK, Germany and Spain are the countries showing the lowest technology gaps between the country-specific cost frontiers and the European metafrontier, while, U.K., Germany, and Italy are the countries showing the lowest technology gaps between the country revenue frontier and the European revenue metafrontier.

We apply panel data models to test β-convergence and σ-convergence and find evidence of the efficiency catch up effect among the 10 EU countries and that the dispersion of the mean efficiency scores (both cost and revenue) among EU countries decreased during the sample period. Therefore, our study provides evidence that integration in the EU insurance markets has taken place in recent years.

Results also provide evidence of β-convergence and σ-convergence in metatechnology efficiency ratios both in the cost analysis and in the revenue analysis, suggesting that the technological discrepancy among the insurance markets of major EU countries has decreased over the sample period.

We conducted multiple regression analysis of metatechnology efficiency ratios on country environmental variables as well as on variables representing characteristics of the firm in the sample. Some of the outstanding findings are that the country's stock market development and debt market development, and the insurer's size increase the metatechnology efficiency ratios (both cost and revenues). However, higher market concentration ratios as a measure of competition lack, inflation and country life insurance penetration decrease both ratios. Both ratios also show a negative and significant relationship with respect to three governance variables (political stability and absence of violence, governance effectiveness and rule of law). The analysis also shows that being headquartered in a country with a common

legal system increase the metatechnology cost efficiency ratio. However, this ratio is negative and significant with respect to the capitalization variable as well as the group variable. Additionally, results show that the level of capitalization and being a group increase the metatechnology revenue efficiency ratio, but this ratio is negatively affected by the firm reinsurance utilization.

These findings support the conclusion that country environmental characteristics, that is stock market development, debt market development, origin of the country legal system, life insurance penetration, market concentration, inflation, political stability and absence of violence, governance effectiveness and rule of law influence the gap between the country frontier and the European metrafrontier. Consequently, they influence the performance and integration of European life insurance markets.

The implications of this research are that regulators and policymakers should be concerned about designing programs involving changes to these environmental variables in order to improve performance and achieve a more integrated EU life insurance market. The analysis presented here should stimulate future research on environmental factors that influence performance and integration as well as the impact of integration on the dynamics of efficiency in the EU non-life insurance market according to the especial characteristics of this insurance segment.

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Table 1. Outputs, Inputs and Prices for European Life Insurers, 1998-2011

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Annual Growth Rate 1998-2011
Outputs															
Losses Incurred	302.90	298.19	302.86	305.18	405.09	481.85	747.19	647.70	820.28	887.19	710.13	847.17	825.23	927.85	9.0%
Invested Assets	4137.70	4321.88	4089.31	4034.84	4764.94	5659.31	7844.65	7706.18	10301.34	10727.31	10919.00	12924.66	13106.74	13942.55	9.8%
Outputs Prices															
Losses Incurred	2.367	2.293	2.005	1.645	1.359	1.586	2.242	3.503	3.098	2.995	2.332	1.914	1.900	1.513	-3.4%
Invested Assets	0.051	0.046	0.045	0.043	0.040	0.038	0.037	0.037	0.035	0.035	0.036	0.034	0.033	0.032	-3.4%
Inputs															
Operating Expenses	64.65	57.43	51.30	53.31	67.00	71.31	118.80	96.49	123.63	122.13	137.04	112.78	129.31	146.66	6.5%
Debt Capital	4043.29	4213.98	3982.78	3965.06	4729.48	5591.02	7771.62	7580.84	10096.69	10549.94	11202.66	13022.70	13029.92	14064.14	10.1%
Equity Capital	287.87	306.69	267.11	240.82	263.01	314.90	433.31	441.03	640.15	583.09	501.90	635.05	678.22	673.60	6.8%
Inputs prices															
Operating Expenses	1.023	1.056	1.090	1.128	1.161	1.186	1.214	1.235	1.259	1.280	1.325	1.354	1.374	1.387	2.4%
Debt Capital	0.048	0.047	0.054	0.049	0.049	0.042	0.042	0.036	0.039	0.043	0.042	0.036	0.040	0.046	-0.4%
Equity Capital	0.191	0.184	0.176	0.160	0.153	0.176	0.174	0.179	0.147	0.133	0.118	0.124	0.109	0.104	-4.5%
Number of firms	452	447	449	455	450	476	532	540	531	466	567	590	606	501	

Notes: This table displays the mean of scores. We use the term firm in the generic sense of decision making unit, including group of firms as well as single unaffiliated insurance firms. Monetary variables are expressed in constant millions 2000 euros deflated by the country-specific consumer price indices.

Table 2. Cost eficiency scores by year and country of European life insurers, 1998-2011

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	1998-2011
Panel A. Metafrontier cost efficiency scores															
Austria	0.523	0.600	0.667	0.644	0.637	0.538	0.595	0.497	0.551	0.572	0.572	0.532	0.566	0.662	0.583
Belgium	0.703	0.547	0.700	0.719	0.532	0.500	0.531	0.479	0.495	0.535	0.530	0.540	0.587	0.574	0.569
Denmark	0.674	0.656	0.702	0.696	0.731	0.680	0.699	0.617	0.627	0.675	0.733	0.720	0.722	0.762	0.693
France	0.603	0.636	0.690	0.681	0.655	0.617	0.622	0.578	0.643	0.666	0.683	0.675	0.708	0.734	0.657
Germany	0.717	0.522	0.585	0.577	0.582	0.514	0.496	0.521	0.586	0.628	0.685	0.673	0.711	0.747	0.610
Italy	0.528	0.598	0.623	0.641	0.638	0.594	0.611	0.595	0.622	0.664	0.654	0.648	0.658	0.686	0.626
Netherlands	0.532	0.554	0.568	0.556	0.478	0.500	0.528	0.481	0.543	0.572	0.537	0.594	0.612	0.622	0.548
Spain	0.577	0.630	0.683	0.649	0.641	0.585	0.575	0.550	0.589	0.634	0.609	0.589	0.606	0.631	0.611
Sweden	0.387	0.373	0.411	0.484	0.550	0.534	0.452	0.362	0.423	0.481	0.505	0.433	0.451	0.491	0.453
UK	0.669	0.671	0.652	0.655	0.626	0.622	0.649	0.620	0.591	0.604	0.617	0.608	0.612	0.646	0.632
EU-10	0.577	0.585	0.625	0.621	0.616	0.565	0.565	0.550	0.588	0.626	0.649	0.637	0.662	0.699	0.612
Panel B. Own-Country cost efficiency scores															
Austria	0.700	0.723	0.787	0.804	0.759	0.769	0.810	0.731	0.768	0.804	0.846	0.807	0.788	0.877	0.784
Belgium	0.676	0.681	0.815	0.807	0.681	0.620	0.614	0.550	0.563	0.601	0.598	0.633	0.659	0.661	0.654
Denmark	0.768	0.763	0.802	0.812	0.827	0.791	0.805	0.750	0.755	0.803	0.834	0.836	0.830	0.875	0.804
France	0.713	0.740	0.781	0.776	0.750	0.723	0.730	0.697	0.747	0.745	0.772	0.764	0.785	0.813	0.753
Germany	0.697	0.537	0.602	0.596	0.599	0.532	0.513	0.542	0.605	0.645	0.701	0.691	0.728	0.763	0.625
Italy	0.658	0.710	0.736	0.731	0.726	0.697	0.717	0.721	0.721	0.734	0.716	0.714	0.721	0.748	0.718
Netherlands	0.599	0.625	0.649	0.635	0.598	0.623	0.644	0.601	0.627	0.644	0.623	0.702	0.717	0.722	0.643
Spain	0.630	0.685	0.740	0.704	0.698	0.657	0.652	0.633	0.677	0.716	0.669	0.656	0.672	0.692	0.677
Sweden	0.568	0.570	0.571	0.649	0.659	0.685	0.609	0.511	0.571	0.648	0.708	0.618	0.620	0.679	0.619
UK	0.682	0.685	0.669	0.672	0.648	0.644	0.668	0.627	0.596	0.616	0.623	0.613	0.622	0.653	0.644
EU-10	0.635	0.639	0.680	0.676	0.671	0.626	0.623	0.613	0.644	0.674	0.700	0.693	0.713	0.745	0.667
Panel C. Metatechnology cost efficiency ratios															
Austria	0.731	0.837	0.855	0.808	0.843	0.725	0.749	0.707	0.740	0.728	0.693	0.682	0.739	0.761	0.757
Belgium	0.814	0.808	0.859	0.894	0.810	0.821	0.864	0.868	0.878	0.888	0.872	0.839	0.883	0.862	0.854
Denmark	0.877	0.854	0.876	0.859	0.884	0.864	0.871	0.826	0.835	0.845	0.878	0.860	0.864	0.866	0.861
France	0.829	0.845	0.880	0.875	0.861	0.838	0.840	0.818	0.860	0.894	0.885	0.879	0.900	0.901	0.865
Germany	0.968	0.961	0.959	0.959	0.969	0.960	0.961	0.953	0.967	0.972	0.976	0.973	0.976	0.980	0.967
Italy	0.801	0.840	0.834	0.867	0.873	0.843	0.845	0.821	0.860	0.905	0.911	0.909	0.916	0.921	0.867
Netherlands	0.868	0.874	0.875	0.870	0.804	0.790	0.811	0.797	0.862	0.890	0.850	0.838	0.850	0.857	0.845
Spain	0.920	0.921	0.926	0.923	0.921	0.895	0.888	0.874	0.874	0.889	0.913	0.901	0.905	0.914	0.905
Sweden	0.726	0.692	0.722	0.746	0.841	0.776	0.753	0.715	0.733	0.738	0.702	0.677	0.720	0.722	0.733
UK	0.930	0.957	0.952	0.968	0.961	0.960	0.969	0.985	0.986	0.980	0.988	0.980	0.968	0.973	0.968
EU-10	0.901	0.910	0.913	0.918	0.918	0.904	0.909	0.898	0.915	0.933	0.927	0.919	0.927	0.936	0.916

Note: This table displays the means of scores for each year and each country.

Table 3. Revenue efficiency scores by year and country of European life insurers, 1998-2011

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	1998-2011
Panel A. Meta-frontier Revenue efficiency scores															
Austria	0.075	0.066	0.076	0.077	0.060	0.064	0.053	0.049	0.070	0.132	0.127	0.121	0.111	0.186	0.090
Belgium	0.091	0.099	0.120	0.119	0.051	0.060	0.058	0.136	0.149	0.173	0.130	0.140	0.078	0.140	0.110
Denmark	0.069	0.061	0.082	0.117	0.107	0.099	0.120	0.163	0.139	0.129	0.145	0.147	0.153	0.178	0.122
France	0.106	0.105	0.110	0.105	0.115	0.138	0.120	0.126	0.137	0.165	0.272	0.194	0.189	0.274	0.154
Germany	0.134	0.123	0.143	0.150	0.176	0.168	0.157	0.164	0.173	0.179	0.190	0.185	0.178	0.213	0.167
Italy	0.018	0.027	0.055	0.041	0.059	0.075	0.136	0.146	0.183	0.215	0.188	0.187	0.171	0.230	0.124
Netherlands	0.102	0.107	0.067	0.108	0.179	0.238	0.211	0.201	0.209	0.177	0.250	0.339	0.375	0.332	0.207
Spain	0.112	0.093	0.126	0.123	0.126	0.156	0.142	0.147	0.197	0.265	0.245	0.153	0.192	0.184	0.161
Sweden	0.122	0.107	0.090	0.102	0.113	0.224	0.299	0.274	0.231	0.215	0.235	0.206	0.192	0.294	0.193
UK	0.214	0.193	0.214	0.223	0.258	0.256	0.305	0.279	0.297	0.284	0.297	0.282	0.303	0.340	0.267
EU-10	0.120	0.114	0.128	0.134	0.153	0.162	0.172	0.174	0.189	0.199	0.214	0.195	0.198	0.236	0.170
Panel B. Own-Country Revenue efficiency scores															
Austria	0.717	0.731	0.741	0.784	0.594	0.689	0.585	0.611	0.683	0.779	0.882	0.840	0.841	0.894	0.741
Belgium	0.501	0.531	0.711	0.583	0.369	0.435	0.379	0.396	0.412	0.461	0.523	0.546	0.423	0.661	0.495
Denmark	0.435	0.434	0.500	0.550	0.551	0.457	0.516	0.650	0.626	0.611	0.647	0.628	0.684	0.702	0.571
France	0.458	0.461	0.486	0.472	0.477	0.487	0.461	0.488	0.501	0.549	0.661	0.562	0.566	0.668	0.521
Germany	0.164	0.150	0.178	0.202	0.214	0.203	0.188	0.200	0.206	0.214	0.230	0.224	0.220	0.258	0.204
Italy	0.090	0.096	0.151	0.149	0.154	0.171	0.245	0.264	0.349	0.414	0.395	0.332	0.328	0.435	0.255
Netherlands	0.288	0.316	0.287	0.390	0.407	0.541	0.496	0.508	0.530	0.449	0.533	0.647	0.670	0.622	0.477
Spain	0.356	0.317	0.390	0.410	0.400	0.433	0.375	0.386	0.458	0.523	0.483	0.407	0.423	0.441	0.414
Sweden	0.584	0.644	0.602	0.601	0.515	0.725	0.818	0.814	0.726	0.716	0.705	0.666	0.613	0.753	0.677
UK	0.355	0.312	0.367	0.366	0.426	0.439	0.471	0.411	0.422	0.407	0.435	0.395	0.436	0.465	0.408
EU-10	0.288	0.273	0.309	0.322	0.337	0.339	0.337	0.345	0.368	0.364	0.412	0.383	0.390	0.426	0.350
Panel C. Metatechnology Revenue Efficiency Ratios															
Austria	0.084	0.079	0.088	0.091	0.081	0.084	0.076	0.068	0.090	0.145	0.134	0.129	0.122	0.194	0.105
Belgium	0.137	0.140	0.156	0.162	0.111	0.111	0.117	0.194	0.204	0.227	0.178	0.186	0.140	0.180	0.160
Denmark	0.148	0.133	0.151	0.183	0.169	0.169	0.185	0.212	0.189	0.177	0.198	0.198	0.201	0.223	0.181
France	0.200	0.201	0.206	0.204	0.217	0.248	0.228	0.235	0.249	0.273	0.364	0.297	0.288	0.356	0.255
Germany	0.862	0.870	0.862	0.843	0.866	0.887	0.894	0.888	0.894	0.896	0.889	0.884	0.872	0.883	0.878
Italy	0.246	0.280	0.298	0.330	0.388	0.432	0.472	0.472	0.468	0.475	0.447	0.468	0.463	0.470	0.408
Netherlands	0.285	0.279	0.261	0.292	0.351	0.410	0.396	0.385	0.399	0.417	0.460	0.496	0.528	0.487	0.389
Spain	0.285	0.289	0.299	0.302	0.300	0.338	0.352	0.349	0.401	0.453	0.413	0.346	0.383	0.382	0.349
Sweden	0.200	0.170	0.159	0.165	0.185	0.269	0.334	0.316	0.284	0.287	0.282	0.262	0.256	0.354	0.252
UK	0.526	0.564	0.549	0.554	0.536	0.523	0.566	0.566	0.565	0.568	0.546	0.581	0.587	0.618	0.561
EU-10	0.496	0.518	0.510	0.515	0.516	0.562	0.583	0.586	0.593	0.631	0.584	0.571	0.566	0.614	0.560

Note: This table displays the means of scores for each year and each country.

Table 4. Tests of convergence in EU life insurance markets. Cost Analysis 1998-2011

Panel A. Convergence of meta-frontier cost efficiency scores				
β-convergence				
	Eq. (9) without lagged dependent variable		Eq. (9)	
β	-0.4498	***	-0.5960	***
γ			0.3003	***
α	-0.2376	***	-0.3194	***
Adjusted R2	0.1499		0.2174	
σ-convergence				
	Eq. (10) without lagged dependent variable		Eq. (10)	
σ	-0.4447	***	-0.3218	***
ρ			0.1245	
α	-0.0064		-0.0428	***
Adjusted R2	0.1748		0.1269	
Panel B. Convergence of meta-technology cost efficiency ratios				
β-convergence				
	Eq. (9) without lagged dependent variable		Eq. (9)	
β	-1.0962	***	-1.2171	***
γ			0.1121	**
α	-0.0394	***	-0.0467	***
Adjusted R2	0.5069		0.5247	
σ-convergence				
	Eq. (10) without lagged dependent variable		Eq. (10)	
σ	-0.6940	***	-0.5766	***
ρ			0.0725	
α	0.0266		0.0119	
Adjusted R2	0.3438		0.3213	

Note: Country dummy variables are not reported. ***, ** mean statistically significant at 1% and 5% level, respectively

Table 5. Tests of convergence in EU life insurance markets. Revenue Analysis 1998-2011

Panel A. Convergence of meta-frontier revenue efficiency scores					
β-convergence					
	Eq. (9) without lagged dependent variable			Eq. (9)	
β		-0.8729	***	-0.8315	***
γ				-0.0439	
α		-1.9173	***	-1.8244	***
Adjusted R2	0.3783			0.3739	
σ-convergence					
	Eq. (10) without lagged dependent variable			Eq. (10)	
σ		-0.7753	***	-0.5981	***
ρ				-0.1474	*
α		-0.1682		-0.1796	**
Adjusted R2	0.3647			0.3334	
Panel B. Convergence of meta-technology revenue efficiency ratios					
β-convergence					
	Eq. (9) without lagged dependent variable			Eq. (9)	
β		-1.1617	***	-1.1797	***
γ				-0.0116	
α		-0.1639	***	-0.1644	***
Adjusted R2	0.5953			0.5988	
σ-convergence					
	Eq. (10) without lagged dependent variable			Eq. (10)	
σ		-0.6633	***	-0.1926	***
ρ				0.0001	
α		0.2505	**	-0.0270	
Adjusted R2	0.3780			0.5116	

Note: Country dummy variables are not reported. ***, ** and * denote statistically significant at 1, 5, and 10% level, respectively

Table 6. Definition of country variables testing hypotheses in the regression analysis.

Variable	Definition	Source
Stock Market Development	Stock Market Turnover Ratio. That is the ratio of the value of total shares traded to average real market capitalization	WBDFDS
Private Bond Market Development	Private bond market capitalization to GDP. That is private domestic debt securities issued by financial institutions and corporations as a share of GDP	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
Bond Market Development	Private bond market capitalization to GDP + Public bond market capitalization to GDP	WBDFDS
Banking Sector Development	Private credit by deposit money banks and other financial institutions to GDP	WBDFDS
Origin of the Country Law System	We use 3 dummies variables: L1 takes 1 for French civil law countries (Belgium, France, Italy, Netherlands and Spain in this study), 0 otherwise; L2 takes 1 for German civil law countries (Austria and Germany in this study), 0 otherwise; L3 takes 1 for Scandinavian civil law countries (Denmark and Sweden in this study), 0 otherwise. The omitted variable is English common law countries.	
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. 2009, 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
Life Insurance Penetration	Total life premium revenues as a share of GDP	WBDFDS
CR5 life ratio	Cumulative market share of the five largest life insurers in a country	Insurance Europe

Notes: 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.

Table 7. Summary Statistics: Variables in the Regression Analysis, 1998-2011.

	Mean	Median	Std. Dev
Dependent Variables			
Metatechnology Cost Efficiency Ratio(MCER)	0.9173	0.9315	0.1093
Metatechnology Revenue Efficiency ratio (MRER)	0.5657	0.5877	0.3225
Independent Variables			
Capital Market Development			
Stock Market Development	1.1856	1.1300	0.4699
Private Bond Market Development	0.4502	0.3921	0.2853
Public bond market development	0.4612	0.4107	0.1696
Bond Market Development	0.9114	0.8133	0.3182
Banking Sector Development			
Banking Sector Development	1.1378	1.1093	0.3346
Governance Dimensions			
Political Stability and Absence of Violence	0.7719	0.8300	0.3726
Government Effectiveness	1.5803	1.6071	0.4258
Regulatory Quality	1.4273	1.4900	0.2861
Rule of Law	1.5004	1.6558	0.3761
Insurance Activity			
Life Insurance Penetration	0.0475	0.0341	0.0249
Competition			
Cumulative Market Share 5 largest insurers	0.4831	0.4930	0.1361
Control Variables			
Total Assets (a)	9003.8	1516.6	43501.5
Equity Capital/Total Assets	0.1010	0.0466	0.1578
Reinsurance Cedded/Gross Premiums	0.1112	0.0116	0.2331
Group	0.0951	0.0000	0.2934
Inflation Rate	1.8854	1.9000	0.9371
Growth in real per capita GDP	1.0422	1.4000	2.2337
Number of observations		6792	

Notes: In order to test hypothesis H3, that is if the origin of the country law system influence the integration of European life insurance markets we alternatively use 3 dummies variables: L1 takes 1 for French civil law countries (Belgium, France, Italy, Netherlands and Spain in this study), 0 otherwise; L2 takes 1 for German civil law countries (Austria and Germany in this study), 0 otherwise; L3 takes 1 for Scandinavian civil law countries (Denmark and Sweden in this study), 0 otherwise. The omitted variable is English common law countries.(a) This monetary variable is expressed in constant million 2000 euros deflated by the country-specific consumer price indices. The log of total assets is included as regressor.

Table 8: Mutliple Regression Analysis on Metatechnology Efficiency Ratios 1998-2011

	Model 1		Model 2		Model 3		Model 4		Model 5	
Dependent Variable	MCER	MRER	MCER	MRER	MCER	MRER	MCER	MRER	MCER	MRER
Independent variables	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Cap. Mks. and Bank dev.										
Stock Market Development	0.025 ***	0.105 ***	0.025 ***	0.105 ***	0.023 ***	0.096 ***	0.025 ***	0.105 ***	0.023 ***	0.096 ***
Public Bond Market dev.	0.056 ***	0.292 ***	0.056 ***	0.291 ***	0.039 ***	0.191 ***	0.054 ***	0.295 ***	0.039 ***	0.173 ***
Banking Sector Development	0.017 ***	0.056 ***	0.013 **	0.053 ***	0.017 ***	0.061 ***	0.017 ***	0.054 ***	0.018 ***	0.063 ***
Country Legal System										
French civil law countries	-0.114 ***	-0.319 ***	-0.089 ***	-0.297 ***	-0.109 ***	-0.286 ***	-0.114 ***	-0.318 ***	-0.111 ***	-0.301 ***
German civil law countries	-0.069 ***	0.135 ***	-0.008	0.186 ***	-0.058 ***	0.197 ***	-0.068 ***	0.133 ***	-0.059 ***	0.199 ***
Scandinavian civil Law	-0.109 ***	-0.370 ***	-0.061 ***	-0.329 ***	-0.097 ***	-0.299 ***	-0.108 ***	-0.372 ***	-0.101 ***	-0.315 ***
Governance Dimensions										
PS			-0.052 ***	-0.044 ***						
GE					-0.014 ***	-0.081 ***				
RQ							-0.005	0.008		
RL									-0.015 **	-0.099 ***
Market dev. and concentration										
Penetration	-0.570 ***	-1.998 ***	-0.017	-1.527 ***	-0.430 ***	-1.162 ***	-0.548 ***	-2.034 ***	-0.465 ***	-1.292 ***
CR5	-0.207 ***	-0.431 ***	-0.182 ***	-0.410 ***	-0.208 ***	-0.437 ***	-0.206 ***	-0.432 ***	-0.204 ***	-0.411 ***
Control Variables										
Country Factors										
Inflation	-0.011 ***	-0.058 ***	-0.007 ***	-0.055 ***	-0.009 ***	-0.046 ***	-0.010 ***	-0.059 ***	-0.009 ***	-0.047 ***
Growth	8E-04	-0.013 ***	0.002 *	-0.011 ***	0.002	-0.004	0.001	-0.013 ***	0.002	-0.006 **
Firm Characteristics										
Log of assets	0.015 ***	0.071 ***	0.015 ***	0.072 ***	0.015 ***	0.071 ***	0.015 ***	0.071 ***	0.015 ***	0.071 ***
Capitalization	-0.215 ***	0.268 ***	-0.211 ***	0.271 ***	-0.214 ***	0.270 ***	-0.214 ***	0.268 ***	-0.214 ***	0.274 ***
Use of Reinsurance	-0.004	-0.067 ***	-0.004	-0.067 ***	-0.004	-0.067 ***	-0.004	-0.067 ***	-0.004	-0.066 ***
Group	-0.012 ***	0.029 ***	-0.006 *	0.034 ***	-0.011 ***	0.037 ***	-0.011 ***	0.029 ***	-0.011 ***	0.037 ***
Log Likelihood	7,149	2,125	7,187	2,131	7,152	2,154	7,149	2,125	7,152	2,156
Observations	6792		6792		6792		6792		6792	

Notes: Coefficients for intercept and year dummies variables are not reported. PS, GE, RQ and RL mean Political Stability and Absence of Violence, Governement Effectiveness, Regulatory Quality and Rule of Law, respectively. *** ,** and * significant at 1%, 5% and 10%, respectively.

Figure1. Metafrontier Cost Efficiency and Metatechnology Cost Efficiency Ratio

Efficiencies for firm operating at point A belonging to country 2:
Country-specific cost efficiency =OB/OA
Metafrontier cost efficiency =OC/OA
Metatechnology cost efficiency ratio =OC/OB = (OC/OA) / (OB/OA)