PREDICTION OF THE INSURANCE INDUSTRY DEMAND FOR A SPECIFIC MULTINATIONAL COMPANY

Robin Koklar, PhD Candidate
The University of Finance and Administration, Prague, the Czech Republic

Abstract

The work deals with the prediction of the insurance industry demand for a multinational company in the field of life and non-life insurance. A system of simultaneous equations was applied for estimation of industry demand in different countries. The advantage of using a set of simultaneous equations is that it is possible to estimate the development of the multiple markets simultaneously. The system of simultaneous equations is estimated by three-stage least squares model and prediction for the years 2012 and 2013 was solved with a dynamic stochastic model.

Keywords: Industry demand estimation, system of simultaneous equations, three stage least squares

Introduction

To estimate the demand for insurance, the Belgian multinational insurance company has been selected due to availability of time series. The selected company Ageas is an international insurance company that does business in the European market and in Asia. There are four markets in Belgium, France, Britain and China that play crucial role for the company. For company valuation it is necessary to estimate the development of the above-mentioned markets. The Ageas company operates in life insurance markets in Belgium, France and China and in non-life insurance market in the UK.

The demand for life insurance was already addressed by Browne[1] (1993) and Outreville[2] (1996), who identified statistically significant determinants in the form of GDP, inflation, cost of insurance and the

---

[1] Browne, Mark J. and Kihong Kim. (1993). An International Analysis of Life Insurance Demand. Journal of Risk and Insurance 60: 616 - 634.
[2] Outreville, Francois J. (1996). Life Insurance Markets in Developing Countries. Journal of Risk and Insurance 63: 263 - 278.

development of financial market. Beck and Webb (2003) applied a panel regression covering 68 countries and the results show that the rate of inflation, income per capita, banking sector development and other religious and institutional indicators are among the most robust determinants for the life insurance demand.[3] Li (2007) found that the demand for life insurance increases with income, number of dependents and education level.[4]

Property and liability insurance demand is in theory positively correlated with risk aversion and probability of loss. The demand is also influenced by total wealth, however, the propensity to insure is dependent on the behavior of risk aversion. In his work Mossin (1968) has analyzed four different scenarios, each concerned with rational behavior of an individual buying insurance against given risks.[5] The author claims that an individual with decreasing risk aversion will assume more risk the larger his wealth is. In his paper Falciglia (1980) applies alternative consumption oriented model for non-life insurance demand, which emphasizes the role of interest rates, that cannot be thought of as independent for the demand.[6] His model is based on the maximization of the expected utility of consumption in two periods and the insurer´s optimal delay of payment after damages were reported to an insurance company. The role of interest rate derives from the delay mechanism between the time the damage is incurred to financial compensation from insurance coverage. However, the results were inconclusive. The relationship between the interest rates and the demand for non-life insurance was found to be negative only when the hypothesis of decreasing absolute risk aversion was accepted. In other words, higher interest rates discourage the demand for non-life insurance in case the agent is a net saver. The author found out that insurance coverage is an inferior good if decreasing absolute risk aversion dominates and only if the hypothesis of increasing absolute risk aversion is valid, the insurance demand displays downward-sloping curve. Haiss (2006) focused on the relationship between insurance sector development and economic growth.[7]

[3] Beck, Thorsten and Ian Webb. (2003). Economic, Demographic, and Institutional Determinants of Life Insurance Consumption across Countries. World Bank Economic Review 17: 51 - 88.

[4] Li, Donghui, Moshirian, Fariborz, Nguyen, Pascal and Timothy Wee. (2007). The Demand for Life Insurance in OECD. The Journal of Risk and Insurance 74: 637 - 652.

[5] Mossin, Jan. (1968). Aspects of Rational Insurance Purchasing. Journal of Political Economy. Vol. 76. No. 4, Part 1, pp. 553-568.

[6] Falciglia, Antonio. (1980). The Demand for Non-Life Insurance: A Consumption-Oreinted Model. The Geneva Papers on Risk and Insurance, 17. https://www.genevaassociation.org/media/219094/ GA1980_GP5(17)_Falciglia.pdf

[7] Haiss, Peter and Kjell Sumegi. (2006). The Relation of Insurance and Economic Growth – A Theoretical and Empirical Analysis. http://ecomod.net/sites/default/files/document-conference/ ecomod2006 /1454.pdf

The insurance helps companies to mitigate the threat accruing from their business activity such as collection of receivables or loss of property.

1. Estimation of insurance demand

Ageas is a multinational insurance company that operates in four key markets. The company provides life and non-life insurance business in Belgium, France, China and the UK. Time series were available for insurance premium written in Belgium, France and the UK, only the Chinese life insurance statistics was shorter than the other. For this reason, the development of China's life insurance market is estimated separately and is not included in this work. Annual time series are available beginning in 1985 to 2011 and denominated in U.S. dollars. Estimation of insurance demand for Belgium, France and the UK is performed with a system of simultaneous equations. At first, more than 70 time series entered the system and variables that enter individual equations are either in line with theory, or are consistent with other work on this topic. The system of simultaneous equations is portrayed in table 1.

Table 1: The system of simultaneous equations

Estimated equations:
Eq1: D(BELIFEPREM) = C(1) + C(2)*D(BERHDP) + C(3)*DUMMY1 + C(4)*DUMMY3
Eq2: D(BERHDP) = C(5) + C(6)*D(FRRHDP)
Eq3: D(FRLIFEPREM) = C(7) + C(8)*D(FRRHDP) + C(9)*D(FRCONSUMCONFID) + C(10)*D(BELIFEPREM)
Eq4: D(FRRHDP) = C(11) + C(12)*D(FRLIFEPREM)
Eq5: D(FRCONSUMCONFID) = C(13) + C(14)*D(FRINCOME) + C(15)*DUMMY5 + C(16)*DUMMY6
Eq6: D(UKNONLIFEPREM) = C(17) + C(18)*D(UKREDUEXPENDINOM)
Eq7: D(UKREDUEXPENDINOM) = C(19) + C(20)*D(UKRHDP)
Eq8: D(UKRHDP) = C(21) + C(22)*D(UKNONLIFEPREM)
Instrumental variables:
DUMMY1 DUMMY3 DUMMY5 DUMMY6 D(FRLIFEEXPECTANCY) D(BELIFEEXPECTANCY) C

Source: Statistics from A to Z. OECD. http://www.oecd.org/statistics/ Eurostat. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00115

Table 2 contains a description of the variables from Table 1 and each equation will be explained in the following chapter. The system of simultaneous equations is proposed to subsume three insurance markets with 8 equations. While testing the model, problem with correlation between the error term and some of the independent variables was encountered. For this reason instrumental variables estimation was applied. Instrumental variables depicted in table 1 include the average life expectancy in Belgium and

France and expected values for the time series for the years 2012 and 2013 were taken from the International Futures.[8]

Table 2: Description of variables from the system of simultaneous equations

frlifeprem	Life instance in France
frrhdp	GDP in France in real terms
frconsumconfid	Consumer confidence in France
frincome	Net national income per capita in France in real terms
uknonlifeprem	Non-life premium written in the UK
ukreduexpendinom	Domestic expenditures in real terms in the UK (Nominal domestic expenditures deflated by index CPI)
ukrhdp	GDP in the UK in real terms
belifeprem	Life premium written in Belgium
berhdp	GDP in Belgium in real terms
belifeexpectancy	Life expectancy in Belgium in years
frlifeexpectancy	Life expectancy in France in years
dummy1	Dummy variable (0, 1 – structural change)
dummy3	Dummy variable (0, 1 – structural change)
dummy5	Dummy variable (0, 1 – structural change)
dummy6	Dummy variable (0, 1 – structural change)

2. Estimation of the system of simultaneous equations

The system of simultaneous equations is formed with 8 equations that enter three stage least squares model (3SLS) depicted in table 3. A 3SLS method was applied because residuals of individual equations were correlated. All coefficients of the independent variables except the three unknown parameters are statistically significant at least at the level of significance of 5 %.

From table 3 and table 1 can be seen that life insurance in Belgium in equation 1 is positively influenced by real GDP of Belgium and dummy variables that represent structural changes. Positive relationship between life insurance premium and real GDP is in line with theory. In the second equation real GDP of Belgium becomes the dependent variable and real GDP of France is an explanatory variable, which has a positive impact on the dependent variable.

Life insurance in France stands out in the third equation in the role of the dependent variable, which is positively influenced by real GDP of France. The growth in GDP is in most cases reflected in higher household income, which in turn results in higher demand for endowment life insurance. In addition, in the third equation an explanatory variable in terms of consumer confidence was found to have a negative impact on life

[8] International futures. *Population Forecast for Belgium.* http://www.ifs.du.edu/ifs/frm_Country Profile.aspx?Country=BE

insurance in France, which is not in line with theory, but is in line with other work.[9]

Table 3: 3SLS model estimating the system of simultaneous equations

Estimation Method: Three-Stage Least Squares				
Sample: 1984 2011				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-151.7342	542.7147	-0.279584	0.7801
C(2)	**2.09E-07**	**8.79E-08**	**2.376235**	**0.0185**
C(3)	**7533.817**	**1559.364**	**4.831338**	**0.0000**
C(4)	**-7837.751**	**1548.632**	**-5.061080**	**0.0000**
C(5)	6.65E+08	6.25E+08	1.063961	0.2887
C(6)	**0.172886**	**0.018137**	**9.532435**	**0.0000**
C(7)	**-30151.74**	**6739.070**	**-4.474170**	**0.0000**
C(8)	**1.12E-06**	**1.81E-07**	**6.200070**	**0.0000**
C(9)	**-1680.135**	**643.1540**	**-2.612336**	**0.0097**
C(10)	**3.101522**	**1.341358**	**2.312226**	**0.0218**
C(11)	**2.46E+10**	**4.03E+09**	**6.112971**	**0.0000**
C(12)	**482894.5**	**134953.0**	**3.578243**	**0.0004**
C(13)	**-5.842538**	**1.247642**	**-4.682863**	**0.0000**
C(14)	**0.015698**	**0.002506**	**6.264106**	**0.0000**
C(15)	**-14.55327**	**3.264686**	**-4.457786**	**0.0000**
C(16)	**35.39310**	**4.432689**	**7.984567**	**0.0000**
C(17)	1410.942	1347.150	1.047354	0.2963
C(18)	**7.38E-07**	**1.59E-07**	**4.646877**	**0.0000**
C(19)	**-7.44E+09**	**1.72E+09**	**-4.334371**	**0.0000**
C(20)	**0.379505**	**0.048387**	**7.843092**	**0.0000**
C(21)	**1.69E+10**	**5.39E+09**	**3.129118**	**0.0020**
C(22)	**2644788.**	**578457.9**	**4.572136**	**0.0000**

Source: Own calculations in Eviews. Presented time series are tested by ADF test and show stationarity. Bold denotes statistical significance at the 5 % level. The output of the employed 3SLS model includes also individual equations with the estimated coefficients, which are not included in this work.

The decline in consumer confidence is likely to translate into higher demand for term life insurance. Finally, additional explanatory variable in the third equation represents life insurance in Belgium, which has a positive impact on the dependent variable. In the fourth equation real GDP of France acts as dependent variable, which is positively influenced by the life insurance premium in France. There was found two-way causality between GDP of France and life insurance demand in France.

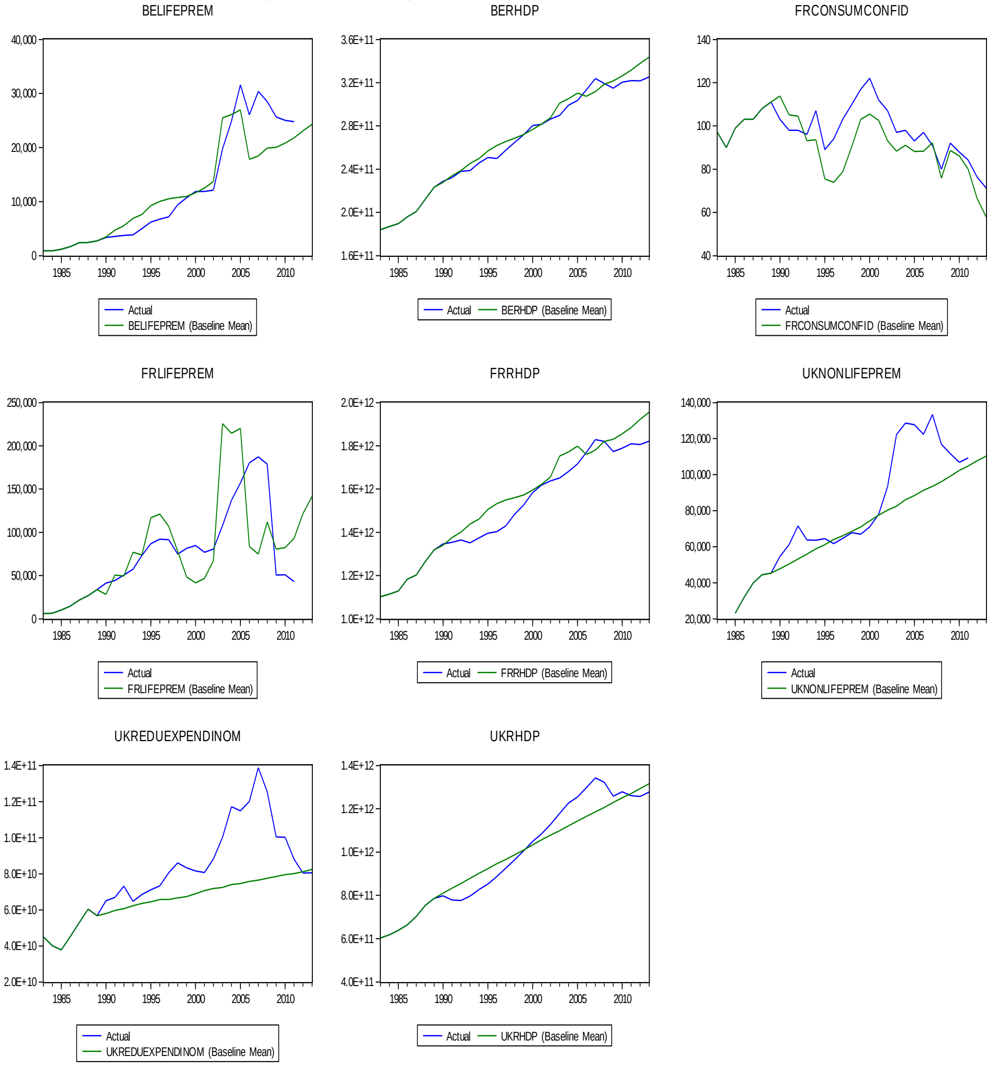
[9] Koklar, R. Determinanty ovlivňující předepsané hrubé pojistné životního pojištění v ČR. In Finanční trhy a jejich regulace v podmínkách doznívání světové finanční krize. Praha: Vysoká škola finanční a správní, 2011. s. 3-10. ISBN 978-80-7408-050-0.

The fifth equation represents consumer confidence in France as a dependent variable, which is positively influenced by net national income per capita in France. The equation 6 of table 1 presents domestic expenditures in real terms in the UK as explanatory variable that has a positive impact on the non-life insurance market in the UK as dependent variable. In the equation 7 a positive relationship was found between domestic expenditures in real terms in the UK as dependent variable and real GDP of the UK. Finally, non-life insurance premium in the UK is an independent variable in the equation 8 and it has a positive impact on real GDP of the UK. There is probably two-way causality present between real GDP of the UK and the non-life insurance premium in the UK. The above described equations represent a system of simultaneous equations, where the number of endogenous variables equal to the number of independent equations.

The above model is used to estimate the three key markets, in which Ageas operates. The Chinese life insurance market is not part of the model described above, since the available statistics was about ten years shorter in comparison with other countries. The estimated 3SLS model is then subjected to the stochastic dynamic model by Broyden for prediction for the years 2012 and 2013 in figure 1.[10]

[10] Broyden, George. A Class of Methods for Solving Nonlinear Simultaneous Equations. http://www.jstor.org/discover/10.2307/2003941?uid=3737856&uid=4582465567&uid=2&uid=3&uid=60&sid=21102730781461

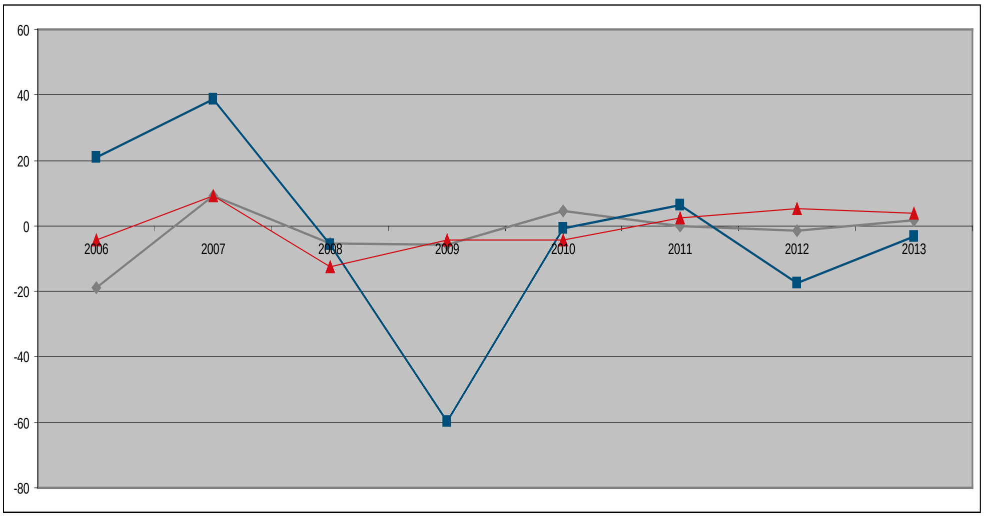
Figure 1: The depiction of actual and estimated values of dynamic stochastic model of the life and non-life insurance in three countries



In figure 1 can be seen the depiction of actual and estimated values of dynamic stochastic model of life insurance in Belgium and France and non-life insurance in the UK. The estimated values of the endogenous variables in figure 1 fairly imitate the trend of the actual values. Since all the coefficients of the independent variables are statistically significant and the estimated values of the endogenous variables of the model follow the trend of actual values, this model can be used for predictive purposes. The expected values for exogenous variables for the years 2012 and 2013 are taken from Eurostat.[11]

Graph 1 shows the development of the life insurance sector in Belgium, France and non-life insurance in the UK with the prediction of the dynamic stochastic model for the years 2012 and 2013 in %.

Graph 1: Development of the life insurance sector in Belgium, France and non-life insurance in Britain with the predictions for the years 2012 and 2013 in %



Note: The blue curve represents the development of life insurance in France and the red curve shows the development in non-life insurance in the UK and the gray curve shows the development of life insurance in Belgium in %. The x-axis displays the time horizon from 2006 to 2011 with subsequent predictions for the years 2012 and 2013.

Conclusion

One of the most important aspects of company valuation is to estimate the development of the industry from which company revenues can be subsequently estimated. The system of simultaneous equations was formed for estimating the life and non-life insurance industry, in which Belgian multinational insurance company operates. Subsequently, the system of simultaneous equations was estimated with 3SLS model and prediction for the years 2012 and 2013 was performed by a dynamic stochastic model. The predicted values of the insurance markets can be used to estimate revenues of Ageas.

[11] EUROSTAT. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00115

References:

Beck, Thorsten and Ian Webb. (2003). Economic, Demographic, and Institutional Determinants of Life Insurance Consumption across Countries. World Bank Economic Review 17: 51 - 88.

Browne, Mark J. and Kihong Kim. (1993). “An International Analysis of Life Insurance Demand.” Journal of Risk and Insurance 60: 616 - 634.

Broyden, G. (1965). A Class of Methods for Solving Nonlinear Simultaneous Equations. http://www.jstor.org/discover/10.2307/2003941?uid=3737856&uid=4582465567&uid=2&uid=3&uid=60&sid=21102730781461

EUROSTAT. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00115

Falciglia, Antonio. (1980). The Demand for Non-Life Insurance: A Consumption- Oreinted Model. The Geneva Papers on Risk and Insurance, 17. https://www.genevaassociation.org/media/219094/GA1980_GP5(17)_Falciglia.pdf

Haiss, Peter and Kjell Sumegi. (2006). The Relation of Insurance and Economic Growth – A Theoretical and Empirical Analysis. http://ecomod.net/sites/default/files/document-conference/ecomod2006/1454.pdf

International futures. Population Forecast for Belgium. http://www.ifs.du.edu/ifs/frm_CountryProfile.aspx?Country=BE

Koklar, R. Determinanty ovlivňující předepsané hrubé pojistné životního pojištění v ČR. In Finanční trhy a jejich regulace v podmínkách doznívání světové finanční krize. Praha: Vysoká škola finanční a správní, 2011. s. 3-10. ISBN 978-80-7408-050-0.

Li, Donghui, Moshirian, Fariborz, Nguyen, Pascal and Timothy Wee. (2007). The Demand for Life Insurance in OECD. The Journal of Risk and Insurance 74: 637 - 652.

Mossin, Jan. (1968). Aspects of Rational Insurance Purchasing. Journal of Political Economy. Vol. 76. No. 4, Part 1, pp. 553-568.

Outreville, Francois J. (1996). Life Insurance Markets in Developing Countries. Journal of Risk and Insurance 63: 263 - 278.

Statistics from A to Z. OECD. http://www.oecd.org/statistics/