Analyzing Risk in Long Term Care Insurance Markets

by

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Abstract

Assessing the distribution of long-term care claims far out into the future is difficult in part because of aggregate risk. Life insurance companies find it particularly difficult to assess and have therefore dropped out of the market or provided packages that do not adequately fulfill the consumers' needs. The present research tries to measure some of the causes of aggregate risk in the long-term care market, and to determine whether risk sharing is feasible across nations. It is accomplished first by using a principal components analysis on long-term care expenditure, and then through multiple regressions that test the sensitivity of the spending to the principal components. The three sections indicate that there is a benefit to be gained from insuring across nations. All the data is from the Organization of economic co-operation and development.

Acknowledgements

First, I would like to thank my thesis advisor, Professor Ralph Koijen, for his oversight on my paper. I was only able to pursue this research with his help and patience. It was an honor to work with professor Koijen and I am grateful for all his help in the past year.

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Introduction

Insurance companies are often reluctant to enter into long-term contracts for life insurance. Previous research has indicated that this is because of adverse selection and excessive regulation. Those likely to have long term losses are the most eager to purchase long term care insurance and public policy such as Medicaid crowds out the market. More recent studies have indicated the importance of intertemporal risk.[1] When insuring far out into the future, the risk is larger because of unforeseen medical technologies or changing mortality rates. When insuring multiple cohorts, if risks are correlated then the ability to share risk across cohorts is diminished. If the risks are uncorrelated, then the payments can be predicted over time. However, even if the risks are uncorrelated the potential payments can be very large and can potentially push the company into bankruptcy. Bankruptcy costs prevent the company from providing long term care insurance because the potential loss will be worse than a larger gain.[2]

Currently, life insurance companies provide indemnity insurance. Indemnity insurance pays out a specified amount at a triggering event such as entering a nursing home. It does not cover recurring risks the way that service coverage could. 70% of people admitted to nursing homes are over the age of 75, and since insurance is sold around 65, there are several unforecastable risks in that time. If aggregate risk factors could be identified, it could potentially be easier to share the risk across nations.[3]

Risk sharing opportunities have in the past been applied to GDP sharing. Using a CARP model, contracts were designed to create markets that hedge against the uncertainty of individuals income. World income components were defined from eigenvectors of a variance

[1] Cutler, David M. 1996. “Why Don't Markets Insure Long-Term Risk?”.
[2] Ibid.
[3] Ibid.

matrix of individual incomes from per capita world income. Using a three-level income model of world shocks, country shocks (uncorrelated), and spatial country shocks (correlated), they were able to explain the variance. The paper found that country size, spatial arrangement, and variations in standard of living can be used to design swaps between the different countries. [4]

There are several variables that have a great impact on long-term care expenditure. The first is the number of dependent people in the population. To study the number of dependent people in the population, life expectancy at birth and per capita health care spending can be used to estimate the decline in dependency ratio at specific age groups. According to the healthy aging hypothesis, the population maintains the same percentage of dependent people, but the dependency is pushed later in life as life expectancy rises. The greater the amount of dependent people in the population, the more the country is likely to spend on health care spending.

Around 70-90% of those who provide care are family members.[5] In several countries, the informal care supply greatly exceeds the formal care supply.[6] There is evidence that the size of the informal elderly care supply is associated with female labor force participation.[7] Therefore, the informal care supply can be studied by measuring the labor force participation rate of women over 50. Female labor force participation has in the past been proven to be a reliable proxy.

The Baumol effect is when there are rising wages in a sector without gains in productivity. Rising costs in other areas can lead to rising costs of LTC. Weak productivity in a nation can be measured by tracking care staff salaries. LTC does not achieve substantial

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[4] Athanasoulis, Stefano, G., and Robert J. Shiller. 2001. "World Income Components: Measuring and Exploiting Risk-Sharing Opportunities." American Economic Review, 91w(4): 1031-1054.
[5] Fujisawa, R. and F. Colombo (2009), "The Long-Term Care Workforce: Overview and Strategies to Adapt Supply to a Growing Demand", OECD Health Working Papers, No. 44, OECD Publishing, Paris.
[6] Colombo, F. et al (2011), Help Wanted? Providing and Paying for Long-Term Care, OECD Publishing
[7] Viitanen, T. K. (2005), Cost of Childcare and Female Employment in the UK. LABOUR, 19: 149-170.

productivity gains,[8] so high wages of care givers can lead to much higher LTC expenditure. Similarly, as real income and GDP per capita rise, care can be directed at higher quality services.[9] The relative price of LTC rises with increasing GDP and income.

Financing schemes, population structure, and geographic location can also lead to LTC expenditure variance. Population structure, such as more people over the age of 65 when the contracts for long-term care are normally bought, would be expected to have a great impact on the amount that a country spends on long-term care.

There are several different financing schemes among the OECD countries. Most of them have collective finance schemes for nursing-care costs. The Nordic countries have universal coverage as part of a tax-funded social-care system and Germany, Japan, Korea, the Netherlands, and Luxembourg have dedicated social insurance schemes. Belgium arranges for long-term care costs in their health system. In total one third of the countries have universal coverage. Some countries do not have a long-term care system but have universal care benefits in cash or in kind. These countries include Austria, France, Italy, Australia, and New Zealand. Two countries have a safety-net system for LTC costs. These countries are the United Kingdom and the United States.[10]

The broad question/issue /hypotheses

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[8] Mosca, Ilaria et al. "Sustainability of Long-Term Care: Puzzling Tasks Ahead for Policy-Makers." International Journal of Health Policy and Management 6.4 (2017): 195–205. PMC. Web. 21 Mar. 2018.
[9] Colombo, F. et al (2011), Help Wanted? Providing and Paying for Long-Term Care, OECD Publishing
[10] Colombo, F. et al (2011), Help Wanted? Providing and Paying for Long-Term Care, OECD Publishing

Long term Care insurance companies find it difficult to assess the distribution of long-term care claims in the future. This led to many long-term care insurance companies experiencing losses and dropping out of the market in the early 2000's. Health shocks are not only controlled by idiosyncratic risk, but also aggregate risk. Changes in aggregate risk have often been omitted in academic and policy debates. Factors such as government policy and behavior vary significantly from nation to nation and can create entire nations that are higher or lower risk.

I am studying the aggregate risk in the long-term care insurance market and the feasibility for risk sharing across nations to diversify country-specific risk. This paper seeks to find what the factors are that cause nations to have similar risk profiles. The first section will be a principal components analysis on the long-term care spending, followed by regression analysis to figure out the factors that contribute to the different components. The regression should show the sensitivity of the long-term care spending to the principal components. This will be followed by an analysis of the aggregate risk and idiosyncratic risk that can be used to divide and share the different kinds of risk. Risk sharing would be made possible by analyzing the risk profiles of the different nations, and then creating contracts that would allow countries to proportionately divide and share the risk.

Data

Data was collected from the organization for economic co-operation and development and the World Health Organization. The data included is long-term care expenditure, life expectancy, healthcare spending, GDP per capita, female labor force participation, and population structure.

The long-term care expenditure includes 32 countries over 15 years. It is in per capita and in 2010 base year USD. Missing values in all the data sets were replaced with the average value for that country over the years. The data had a mean of 458.3, median of 391.6, minimum value of 4.2, maximum value of 1623.4, and standard deviation of 389.1. Long term care expenditure has been slowly growing in the countries over the last 15 years.

Life expectancy data contained 14 years of data and 32 countries. The data had a mean of 79.23, median of 80.1, minimum value of 70.1, maximum value of 83.9, and standard deviation of 2.899. The values were life expectancy at birth.

Healthcare spending data contained 14 years of data and 32 countries. The data had a mean of 3020.6, a median of 3036.3, a minimum value of 605.6, a maximum value of 6493.8, and a standard deviation of 1336.9. The values are in USD, constant prices, 2010 purchasing power parity.

GDP data contained 14 years of data and 32 countries. The data had a mean of 35478.4, a median of 35543.7, a minimum value of 11602.7, a maximum of 91280.1, and a standard deviation of 13280.1. The values are in USD, constant prices, 2010 purchasing power parity. It is measured per capita.

Labor force participation of females over the age of 65 contained 14 years of data and 32 countries. The data had a mean of 44.6, a median of 46.1, a minimum value of 11, a maximum of 85.3, and a standard deviation of 16.7. It is measured as a percentage of females between 55-64 years old.

Population structure is the percentage of people over the age of 65. Population structure contained 14 years of data and 32 countries. The data had a mean of 15.3, a median of 15.8, a minimum value of 6.6, a maximum of 26.6, and a standard deviation of 3.3.

	Long Term Care Expenditure	Life Expectancy	Healthcare Spending	GDP	Labor Force Participation	Population Structure
Mean	458.2	79.2	3020.6	35478.4	44.6	15.3
Median	391.6	80.1	3036.3	35543.7	46.1	15.8
Minimum	4.23	70.1	605.6	22602.7	11.0	6.6
Maximum	1623.4	83.9	6493.8	91280.1	85.3	36.6
Standard Deviation	389.1	2.9	1336.9	13280.2	16.7	3.3

Figure 1: Summary Statistics of the data used and collected from the OECD

The Methodology

Principal components analysis creates a variance matrix that can find the nations that move together. It reduces the dimensions of the data to k-1 and enables the user to find the components that contribute to most of the variance. Principal axes are made that coincide with directions of maximum variation. The variance is removed, and the process is repeated. The line of maximum variation creates projected values corresponding to the original data points called principal component scores. If all the countries have the same variation that would mean that risk sharing is not possible because they all contain the same risk factors. In this case, there would be one component and the risk would not be able to be diversified. If there is more than one component, there is an indication that the risk can be diversified across the nations that are uncorrelated. The principal components analysis was conducted using the computer programming language Matlab.

To figure out the contributing factors to the principal components, multiple regressions were used. The factors influencing the exposures have been chosen through review of previous research. The factors determined to be important through previous research are life expectancy, population structure, health care spending, labor force participation of women over 50, and GDP per capita. Long term care spending can be used as the response variable in a regression against the time series data of the principal components according to the formula:

$$\lambda_{CT} = \alpha + (Y_0 + Y_1 X_{CT}) F_{1T} + (\delta_0 + \delta_1 X_{CT}) F_{2T} + e_{CT}$$

In this equation F represents the first and second principal components. X is the factor such as life expectancy, which interacts with the principal components. Y and δ represent the regression coefficients and λ is the long-term care expenditure. This regression can show how the factor contributes to the variance through the interaction with the principal component data.

The different factors can be standardized to make the data comparable according to the formula:

$$X_{CT}^{Z} = (X_{CT} - \bar{x}_T) / SD_z (X_{CT})$$

By comparing the different values, you can see the change in sensitivity of spending to the different principal components. The higher the regression coefficient of the interaction between the principal component and the factor, the more sensitive the long-term care expenditure is to that principal component. The data was compiled and organized on microsoft excel, and then exported to Windows software Minitab. The regressions were performed in Minitab.

Using the regression data, a set of contracts can then be made to share and divide the risk. The first contract can be used to divide the aggregate risk. There is a piece of the risk that cannot be shared which is equal to:

$$\lambda_t = Y_0 F_{1T} + \delta_0 F_{2T}$$

The payment that each country would be required to pay would be equal to:

$$(Y_1 X_{CT} / N_{CT} F_{1T}) * N_{CT} + (Y_1 X_{CT} / N_{CT} F_{1T}) * N_{CT}$$

N is equal to the number of people in each country and is used for the size adjustment. The payments were organized in Microsoft Excel. The data was pulled from the regression equations previously calculated.

The second contract is used to share the idiosyncratic risk. The payments and exposures can be seen in the formula:

$$\sum^{C} N_C \lambda_{CT} = \alpha + \sum^{C} N_C + \sum^{C} N_C e_{CT}$$

All the data was created in Minitab and then organized in Microsoft excel. Using the residual values found through the regressions, the payments, exposures, and long-term care expenditure after insurance can be calculated. The volatility changes were computed using Microsoft Excel.

Principal Components Analysis

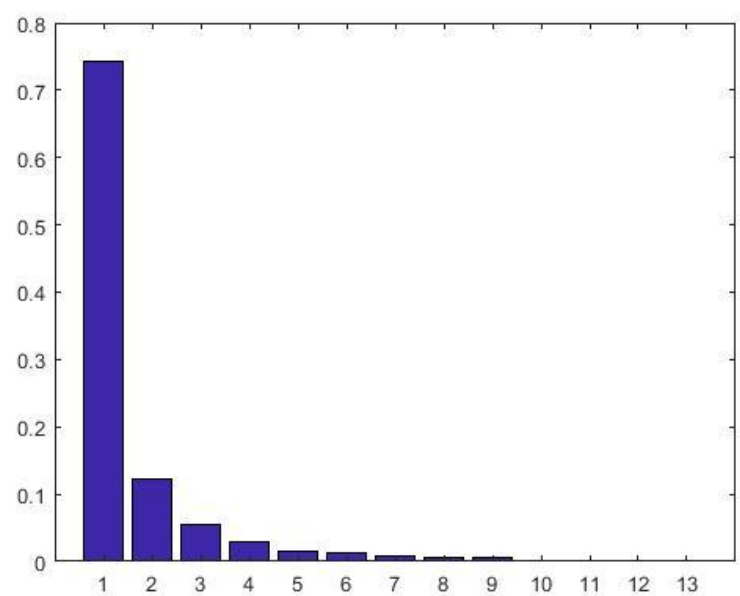

Figure 2: Principal components that explain the variability in the long-term care expenditure data.

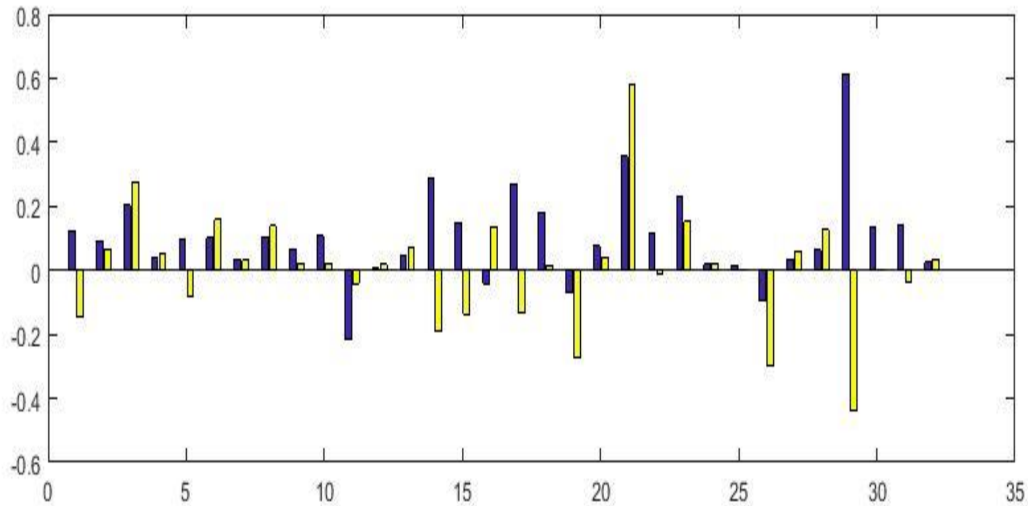

Figure 3: Principal Components analysis loading factors for the 32 different countries
The countries from left to right are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States.

The previous graphs were made using the computer programming language Matlab. The sample is 32 nations with 15 years of long term care expenditure. Figure 2 shows the principal components that explain the variability in the sample. The first principal component explains approximately 75% of the variability and the second one explains approximately 15%. Since all the variance is not explained by the principal components there is a positive indication for the possibility of risk sharing. In this case, there seem to be two main factors explaining the risk, as well as some that is unexplained by a major principal component.

Figure 3 shows the loading factors that correlate the nation (variable) and the principal component. The blue lines are correlations between the variable and the first principal component, and the yellow lines are the correlations between the variable and the second principal component. The variables can be grouped based on their loading factors to see which ones share similar risk which explains the variance. The ones with the largest loading factors have the most exposure to the principal component. The countries with positive values for principal component 1 are Australia, Austria, Belgium, Canada, Czech Republic, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Israel, Japan, Korea, Latvia, Luxembourg, Netherlands, New Zealand, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The countries with positive values for principal component 2 are Austria, Belgium, Canada, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Japan, Latvia, Netherlands, New Zealand, Poland, Portugal, Spain, Sweden, and the United States.

Regressions

To figure out the factor(s) that contributes to the sensitivities of spending to the principal components, regressions were run using the time series data of the principal components. The regressions were run according to the following equation.

$$\lambda_{CT} = \alpha + Y_0 F_{1T} + Y_1 X_{CT} F_{1T} + \delta_0 F_{2T} + \delta_1 X_{CT} F_{2T} + e_{CT}$$

In Figure 4, X is the factor that contributes to the principal component, Y_1 is the coefficient of the interaction between the factor and the first principal component, and δ_1 is the coefficient of the factor and the second principal component.

X	Y_1	δ_1

Life Expectancy	0.06871	0.0329
Health care per capita	0.05150	0.0499
GDP per capita	0.06261	0.0524
Labor force participation	0.06549	0.0320
Population over 65	0.00047	0.0215

Figure 4: Regression coefficients for the interaction between the risk factor and the principal components.

The first regression with the two principal components and life expectancy according to the previous formula yielded a Y_1 value of 0.06871 and a p value of .000. The correlation of life expectancy and the second principal component was not significant. This shows that countries sensitivity to principal component one varies with life expectancy and that the countries sensitivity to principal component 2 does not vary significantly with life expectancy. The values in red are not statistically significant and do not vary with the principal component.

Figure 5: Life expectancy

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	69.3	33.2	2.08	0.038	
PC1	0.10259	0.00792	12.95	0.000	1.00
PC2	-0.0018	0.0186	-0.09	0.925	1.00
PC1X	0.06871	0.00919	7.47	0.000	1.02
PC2X	0.0329	0.0202	1.63	0.103	1.01

Figure 6: Healthcare

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	64.9	33.3	1.95	0.052	
PC1	0.09763	0.00798	12.24	0.000	1.01
PC2	-0.0056	0.0187	-0.30	0.765	1.01
PC1X	0.05150	0.00702	7.33	0.000	1.05
PC2X	0.0499	0.0171	2.91	0.004	1.03

Figure 7: GDP per Capita

Figure 8: Labor Force Participation

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	63.6	33.0	1.93	0.055	
PC1	0.10109	0.00787	12.85	0.000	1.00
PC2	-0.0031	0.0184	-0.17	0.865	1.00
PC1X	0.06261	0.00799	7.84	0.000	1.01
PC2X	0.0524	0.0186	2.81	0.005	1.01

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	64.6	33.5	1.93	0.054	
PC1	0.10173	0.00797	12.76	0.000	1.00
PC2	-0.0017	0.0187	-0.09	0.928	1.00
PC1X	0.06549	0.00887	7.39	0.000	1.04
PC2X	-0.0320	0.0195	-1.64	0.102	1.03

Figure 9: Population Structure

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	67.9	35.4	1.92	0.056	
PC1	0.10299	0.00844	12.20	0.000	1.00
PC2	-0.0011	0.0198	-0.06	0.956	1.00
PC1X	0.00047	0.00901	0.05	0.958	1.06
PC2X	0.0215	0.0215	1.00	0.317	1.03

Figures 5-9 show the coefficients of multiple regression according to the formula $\lambda_{CT} = \alpha + Y_0F_{1T} + Y_1X_{CT}F_{1T} + \delta_0F_{2T} + \delta_1X_{CT}F_{2T} + e_{CT}$

Risk Sharing Contracts

The long-term care risk can be divided into aggregate risk factors and country specific idiosyncratic risk, which could be shared via a pooled insurance scheme. The aggregate risk factors are those used in the regressions and the idiosyncratic risk is the value that is not explained by the regression equation. The equation to represent this is:

$$\Lambda_{ct} = \beta_c F_t + e_{ct}$$

In this equation, Λ represents the long-term care expenditure of a country, β is equal to the regression coefficient, F is the aggregate risk factor and e is the country specific risk to be shared. The equation is analogous to the one used in the multiple regression section to test the sensitivity of the expenditure to the principal components. If that equation is rearranged, the following equation can be formed:

$$\lambda_{CT} = \alpha + (Y_0 + Y_1 X_{CT}) F_{1T} + (\delta_0 + \delta_1 X_{CT}) F_{2T} + e_{CT}$$

This equation shows the aggregate risk and the country specific risk. The factor in the equation, $X_{CT,}$ is standardized and has an average of zero. So, for every country with a positive value of X_{CT} there is a country with a negative value of X_{CT} which can turn the portion of the equation $Y_1 X_{CT}$ to equal to zero. The equation can then be simplified to:

$$\lambda_{CT} = Y_0 F_{1T} + \delta_0 F_{2T} + e_{CT}$$

The different factors such as labor force participation, GDP per capita, population structure etc. cannot be shared in a way that makes the exposure to the risk factor disappear. However, these factors can be effectively divided up. It is divided up between nations in a way that makes every nation carry a proportional burden of the risk relative to the nations size by changing the amount of volatility.

The country specific risk factor is idiosyncratic risk and can be risk shared. The idiosyncratic risk is unsystematic risk that is found in one country but not likely to be found in all.

If the covariance of the country specific risk is zero, and the value of the number is constant over time, then there is possibility for a pooled insurance scheme that diversifies this risk.

$$\text{Cov}(e_{it}, e_{jt}) = 0$$

$$1/N \sum^{N}{}_{C}\, e_{CT}$$

A set of contracts can be made to divide and share the risk of the nations. The first contract would divide the aggregate risk factors of the nations. Every country that is being studied is not equal in size, so a country the size of the United States will not be able to divide the risk equally with a country such as Estonia. After comparing the risk profiles of different countries such as sensitivity to certain aggregate risk factors and the size of the nation, the risk can then be divided between the different nations. The aggregate risk can be defined as:

$$\lambda_{CT} = (Y_0 + Y_1 (X_{CT})) F_{1T} + (\delta_0 + \delta_1(X_{CT})) F_{2T}$$

In this equation X_{CT} demeaned so that the sum of X_{CT} is equal to zero. Since long term care expenditure is in per capita, the total long-term care expenditure in each country is equal to:

$$L_{CT} = \lambda_{CT}*N_{CT} = [(Y_0 + Y_1 (X_{CT})) F_{1T}]*N_{CT} + [(\delta_0 + \delta_1(X_{CT})) F_{2T}]*N_{CT}$$

Simplifying the previous formula gives the following formula:

$$L_{CT} = N_{CT} (Y_0F_{1T} + Y_1X_{CT}F_{1T}) + N_{CT} (\delta_0F_{2T} + \delta_1X_{CT}F_{2T})$$

The total long-term care expenditure across countries would be:

$$L_T = \sum_C L_{CT} = (\sum_C N_{CT})\ Y_0F_{1T} + Y_1F_{1T}\sum_C X_{CT} + (\sum_C N_{CT})\ \delta_0F_{2T} + \delta_1F_{2T}\sum_C X_{CT}$$

Since the sum of X_{CT} is equal to zero because the values are standardized, the previous formula simplifies to:

$$L_T = \sum_C L_{CT} = (\sum_C N_{CT})\ Y_0F_{1T} + (\sum_C N_{CT})\ \delta_0F_{2T}$$

The per capita long-term care expenditure across countries is:

$$L_t / \sum_C N_{CT} = \lambda_t = Y_0F_{1T} + \delta_0F_{2T}$$

The total long-term care expenditure without risk sharing is:

$$\lambda_t = (Y_0 + Y_1X_{CT})\ F_{1T} + (\delta_0 + \delta_1X_{CT})\ F_{1T}$$

The total long-term care expenditure with risk sharing is:

$$\lambda_t = Y_0F_{1T} + \delta_0F_{2T}$$

The insurance payment per country would be:

$$P_{CT} = (Y_1X_{CT}F_{1T}) *N_{CT} + (Y_1X_{CT}F_{1T})*N_{CT}$$

These equations show that there is a portion of the aggregate risk that cannot be divided. All countries face an exposure that is equal to $Y_0F_{1T} + \delta_0F_{2T.}$ However, since the countries do not have equal values of X_{CT}, there will be some countries that are exposed to increases in long-term care expenditure for a fixed level of F, and other countries where long-term care expenditure will decrease for a fixed level of F. This portion that varies with X_{CT} can be divided among the different countries, and the values of the payments are shown in Table A.

The second contract to be made would share the idiosyncratic risk. If the error factors are constant over time, then the risk can be mitigated through diversification between the nations. This risk factor does not affect all the nations studied and is unpredictable. The negative impact of this risk can be minimized through diversification and hedging. In any given year, each country has risk e_C which has a mean of zero across countries. If the countries are equal in size, then the total risk is the sum of e_C and everyone would pay the same share. The average of e_C /I would converge to a value of zero.

$$1/C \sum^{C}_{i} e_{CT} = 0$$

As C (number of countries) becomes infinitely large, the value of e_{CT} becomes closer to 0. Thus the payment made by each country would also equal 0 and the payment required by each country in each period would be:

$$P_{CT} = 1/C \sum^{C} e_{CT} - e_{CT}$$

$$\sum^{C} P_{CT} = 0$$

Therefore, the value of long-term expenditure after pooling the risk is:

$$*\lambda_{CT} = \lambda_{CT} + P_{CT} = \alpha + 1/C \sum^{C} e_{CT}$$

To adjust for the size differences, every country would pay a premium that is proportional to their size. The payment could be found using the following formula:

$$\sum^{C} N_C \lambda_{CT} = \alpha + \sum^{C} N_C + \sum^{C} N_C e_{CT}$$

The benefit of a pooled insurance scheme can be seen by calculating the volatility of the long-term care spending before and after the risk sharing contract. As seen in table B in the appendix, the volatility decreased after the risk sharing contracts were drawn. Figures 10 and 11 show two countries with clear gains from the decrease in volatility from the risk sharing contracts. The transfer payments are shown in table C in the appendix.

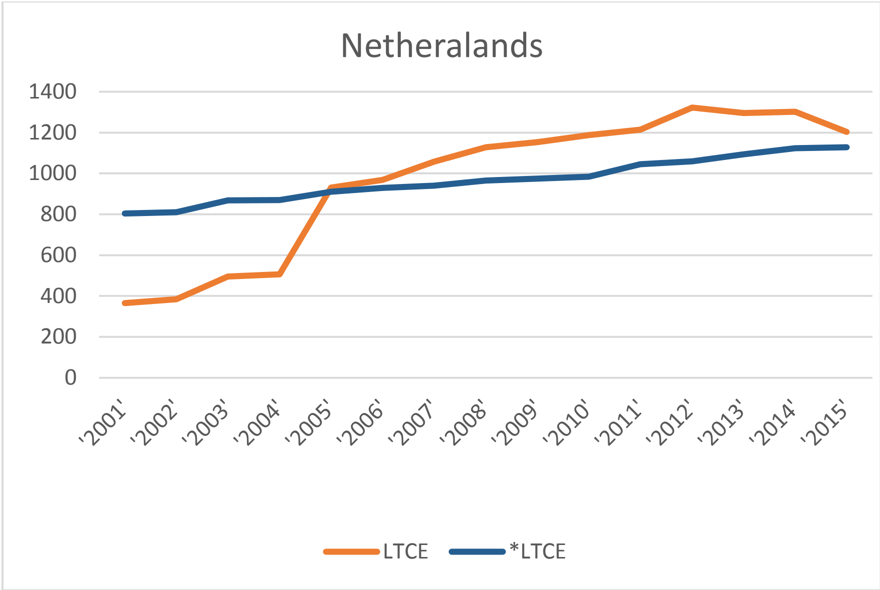

Figure 10: Long term care spending in the Netherlands before and after contract 2.

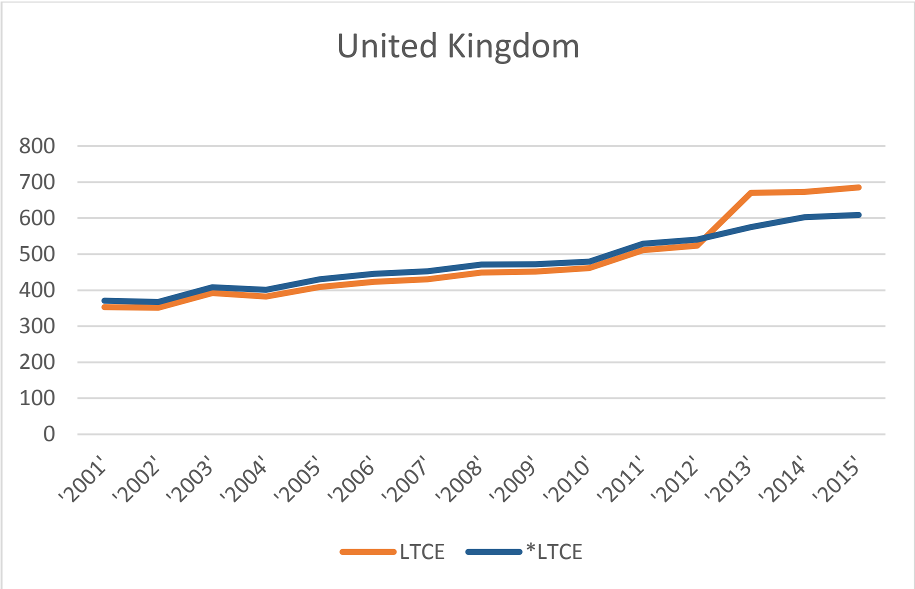

Figure 11: Long term care spending in the United Kingdom before and after contract 2.

Conclusion

The principal components analysis, regressions, and risk sharing contracts indicate that there is a benefit to be gained from insuring across nations. The principal components analysis indicated that one aggregate risk factor did not account for all the variability in long-term care expenditure over time and across nations. PCA showed that there were two main risk factors. The regression analysis showed that exposure to the first and second aggregate risk factor varies with certain measures such as GDP per capita and life expectancy. The different exposures to the risk factors could be modified by using transfer payments to divide a portion of the aggregate risk. A pooled insurance contract showed that it was possible to share the idiosyncratic portion of the risk in a way that reduced the volatility of the long-term care expenditure over time.

Challenges and issues with collection of data

The analysis of aggregate risks is difficult because there are so many factors that influence the amount that is spent on long term care. The type of care the elderly are receiving is often difficult to measure. The effect of certain factors such as government policy may be hard to judge.

Challenges and issues with empirical analysis

Some behaviors are very hard to quantify. Societal trends such as young people living with their parents are very difficult to measure and can have a large impact on the informal care force. In some cultures, it is more common to have parents living with their children until an old age and in others it is more common for the elderly to live on their own. Finding the informal care supply is difficult and can best be proxied by measuring the labor force participation of women over the age of 50.

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Appendix

Table A: Transfer payments by country to divide aggregate risk

Country	2005	2010	2015
Australia	-103067491.6	288166654.8	688535267.9
Austria	-36673999.33	102482816.4	169661459.1
Belgium	-34866373.05	85820880.68	110939331.9
Canada	-145561439	269631795.9	616712955.6
Czech Republic	96926227.37	-198838132.8	-426661318
Denmark	-77390808.25	145739936.8	279416347.7
Estonia	16225101.12	-41462811.05	-75447764.48
Finland	-3131191.884	6300351.209	-5314191.318
France	-16586711.31	-68265015.63	-561206152.7
Germany	-124960365.6	601645059.8	1485434189
Greece	61531694.29	-188939550.1	-739843691.6
Hungary	121023291.9	-309691496	-658208922.1
Iceland	-1204868.346	1320135.067	5330792.03

Ireland	-44514910.45	68445580.82	478637213.9
Israel	75393610.12	-138261008	-293809327.2
Italy	-46710849.52	-228491495.8	-1526937511
Japan	54898036.89	-401428581.2	-955663474.7
Korea	451570734.2	-662735008.3	-1059430862
Latvia	32441571.37	-78274738.98	-148588108.4
Luxembourg	-24623187.05	60385042.38	131569220.2
Netherlands	-109137743.9	288945430.1	530851837
New Zealand	20921617.39	-52760575.41	-109955970.7
Norway	-108024888.2	237598971	500269659.4
Poland	636018740	-1256831496	-2528464361
Portugal	80327393.85	-199692871.4	-568500857.4
Slovak Republic	75515371.93	-133981286.2	-263698011.8
Slovenia	17168276.07	-38091462.03	-100347850.4
Spain	127458901.5	-446165569.4	-1483064988

Sweden	-40396296.62	107028307.5	252911587.8
Switzerland	-108256100.1	289792998.2	604233179.3
United Kingdom	-73364907.66	-86716833.67	-116593828.9
United States	-3863752214	8107193916	19717458444

Table B: Volatility of countries long term care spending before and after contract 2

Country	Volatility before Contract 2	Volatility After Contract 2
Australia	1.484364	3.4628643
Austria	0.024179	0.0751163
Belgium	0.261208	0.0219
Canada	0.030126	0.0325721
Czech Republic	0.558962	0.1870241
Denmark	0.02667	0.0190348
Estonia	0.346883	0.8389656
Finland	0.043626	0.0320629
France	0.049588	0.2460084
Germany	0.010648	0.0295943
Greece	0.386756	0.058823
Hungary	0.412068	0.4336017
Iceland	23.68079	17.400145
Ireland	0.224711	0.0365828
Israel	0.643668	0.08325
Italy	0.122376	0.0436025
Japan	0.315706	0.0401389
Korea	0.306388	0.128972
Latvia	0.316803	0.1976915
Luxembourg	0.071903	0.0392828
Netherlands	0.227092	0.0201282
New Zealand	1.087662	1.0163833
Norway	0.032057	0.0197008
Poland	0.267526	0.2590307
Portugal	0.369145	0.9812606
Slovak Republic	0.270666	0.3270179
Slovenia	0.173237	0.0709377
Spain	0.874522	0.0725275

Sweden	0.910741	0.0308324
Switzerland	0.015772	0.0225866
United Kingdom	0.077396	0.0342636
United States	0.014052	0.0553264

Table C: Transfer Payments made by each country.

Year	Australia	Austria	Belgium	Canada	Czeh Repul	Denmark	Estonia	Finaland	France	Germany
'2001'	-77.1573	-30.453	331.668	-64.8801	26.27761	7.698139	54.39761	60.666	-40.6006	-19.0545
'2002'	-79.2503	-42.9557	333.0666	-83.4482	11.48763	1.288814	36.405	35.80496	-70.6403	-33.5798
'2003'	-34.6809	2.214379	33.54015	-34.3275	33.45302	38.83093	44.11076	48.60668	5.276729	7.906218
'2004'	-38.4094	-24.8397	21.26558	-65.7408	7.288633	-7.27166	-6.14889	10.25891	-21.4805	-2.77995
'2005'	-1.04828	6.398306	55.43413	-28.675	8.031677	-2.30462	-18.9118	18.91673	-12.5009	10.6055
'2006'	15.46696	2.235919	-46.9096	-20.9557	9.755445	-8.33449	-22.8338	-10.2291	12.96287	7.759412
'2007'	30.27305	1.900138	-60.3959	-23.7555	5.69781	-52.783	-28.8252	-36.7706	7.725612	5.761459
'2008'	49.72614	-4.05491	-71.6404	-9.32657	23.66557	-32.5525	-33.1586	-38.8816	3.235329	9.443422
'2009'	55.6717	-41.1279	-117.015	-46.1014	9.304628	-93.0285	-50.6244	-55.062	-25.6159	-17.6901
'2010'	37.7867	-45.3032	-113.89	-40.4906	11.45507	-64.4794	-46.6593	-56.9971	-31.126	-30.9929
'2011'	95.17846	8.874511	-74.5949	49.73539	46.9362	7.765613	-6.22076	-44.0039	9.508009	9.230074
'2012'	68.15252	-2.91062	-79.3951	60.75234	52.04068	37.37487	-4.21068	-54.7694	10.99926	6.017456
'2013'	105.6778	33.10232	-62.2862	84.81456	-83.9863	58.34708	15.62379	-3.58087	33.70962	11.65174
'2014'	131.4503	60.2506	-76.4843	116.4571	-88.7587	51.25149	27.47999	40.92046	51.62072	23.74243
'2015'	-371.082	63.54793	-84.4352	92.90342	-85.3231	45.00928	27.60527	71.81926	54.40766	-0.50337

Year	Greece	Hungary	Iceland	Ireland	Israel	Italy	Japan	Korea	Latvia	Luxembou
'2001'	-170.746	41.15344	143.762	31.76765	24.50782	-80.1242	86.20028	112.0659	-195.515	-221.383
'2002'	-178.983	21.54855	49.60304	27.30078	26.41074	-76.1344	74.96916	94.82898	-212.864	-250.112
'2003'	-193.945	0.112734	-55.9397	41.80666	60.2023	-67.5863	97.81412	114.243	-249.164	-207.362
'2004'	-206.583	-34.3119	-106.068	50.68777	34.91334	-63.9041	71.71719	81.37661	44.13389	-286.566
'2005'	-216.604	-38.0613	-116.443	69.9458	41.62812	-59.4986	85.51133	77.27919	55.20788	-213.015
'2006'	-220.857	-25.2777	-105.876	75.84566	14.96544	-59.1171	103.3185	64.73544	48.65682	-146.986
'2007'	-223.551	-31.4768	-92.8954	81.10832	20.51344	-58.9045	104.3183	33.54847	47.74485	69.07151
'2008'	-228.206	-25.3745	-50.8393	86.51575	28.31723	-59.7087	125.5998	12.65958	47.44937	85.88362
'2009'	204.854	-33.2788	10.16992	91.04895	33.03055	-62.9471	106.205	-44.8283	31.90749	60.31045
'2010'	202.4307	-33.0968	55.00896	90.05796	32.70789	-66.0527	102.2536	-77.759	14.53735	40.36682
'2011'	235.7892	3.993357	34.26316	101.7737	74.93135	-68.0409	-196.398	-59.6231	38.3173	273.5495
'2012'	230.7867	6.816239	52.99039	105.6484	78.55809	141.3866	-225.649	-81.554	41.62152	176.7429
'2013'	240.6466	28.71942	46.80304	-306.949	101.2208	171.2521	-223.18	-92.6339	79.3733	201.2362
'2014'	256.3153	45.69917	62.64427	-308.867	-287.332	193.4308	-218.511	-111.041	89.97256	217.1864
'2015'	256.1867	60.02236	59.68182	-250.15	-297.092	202.6874	-76.8409	-135.863	105.9531	188.7664

Year	Netherlanc	New Zealar	Norway	Poland	Portugal	Slovak Rep	Slovenia	Spain	Sweden	Switzerlanc	United King	United Stat
'2001'	437.6327	27.31853	92.78378	-239.699	-38.8771	-268.988	-158.808	89.42325	218.2347	-46.2603	17.69147	-147.441
'2002'	426.5379	20.63614	7.713579	54.9886	-44.623	-282.028	33.54756	84.98035	203.6168	-88.918	16.03962	-148.38
'2003'	372.6759	12.813	38.72073	64.26675	-8.44561	-310.08	39.63361	-3.95056	249.0627	-39.7439	16.59075	-99.5529
'2004'	363.4117	35.4934	19.70293	8.996231	-31.0729	35.88322	-0.71718	-35.5421	236.5093	-47.2719	18.19702	-96.2882
'2005'	-20.2433	50.64411	60.74804	-5.88456	-19.0563	33.11169	-16.7	-26.0844	266.5009	-9.38268	21.35451	-50.6569
'2006'	-38.8514	29.9623	59.08499	-7.31634	-11.2402	37.83195	-11.4072	-31.6611	272.447	23.63515	21.94833	-28.6224
'2007'	-117.326	28.47451	55.01946	-9.62649	-12.6013	37.96703	-12.4921	-34.862	281.8718	13.80103	22.42663	-31.9607
'2008'	-163.363	-14.3076	-49.7946	-4.12938	-4.12555	48.10798	-19.5898	-26.7356	307.9503	29.61493	22.33645	-10.0434
'2009'	-178.583	-18.1875	-83.7682	-18.0032	-16.3252	37.99766	-24.805	-49.7023	311.7866	14.41049	20.67368	-5.46206
'2010'	-204.602	-22.9246	-66.8206	-23.8066	-14.9996	43.98163	-30.4848	-70.4262	323.4781	0.882991	17.5967	-2.37196
'2011'	-169.53	-27.2965	-14.4969	6.141367	17.94902	82.7724	8.144037	-17.3918	-541.053	29.87473	17.49308	59.37298
'2012'	-264.108	-29.5559	-37.4289	-0.67923	13.96928	87.07927	6.570581	-10.1673	-546.436	13.75888	17.03275	86.02876
'2013'	-202.481	-30.8908	-23.8383	36.77847	38.67134	115.413	43.89897	24.86305	-532.299	34.56434	-95.5946	131.191
'2014'	-178.627	-33.0486	-36.3839	60.04284	54.80063	138.2503	59.2154	47.14016	-521.532	46.00788	-70.2731	165.9402
'2015'	-75.1687	-42.3457	-33.7156	65.69519	63.3501	149.7923	71.8538	47.39563	-542.424	12.15749	-76.4949	166.0311