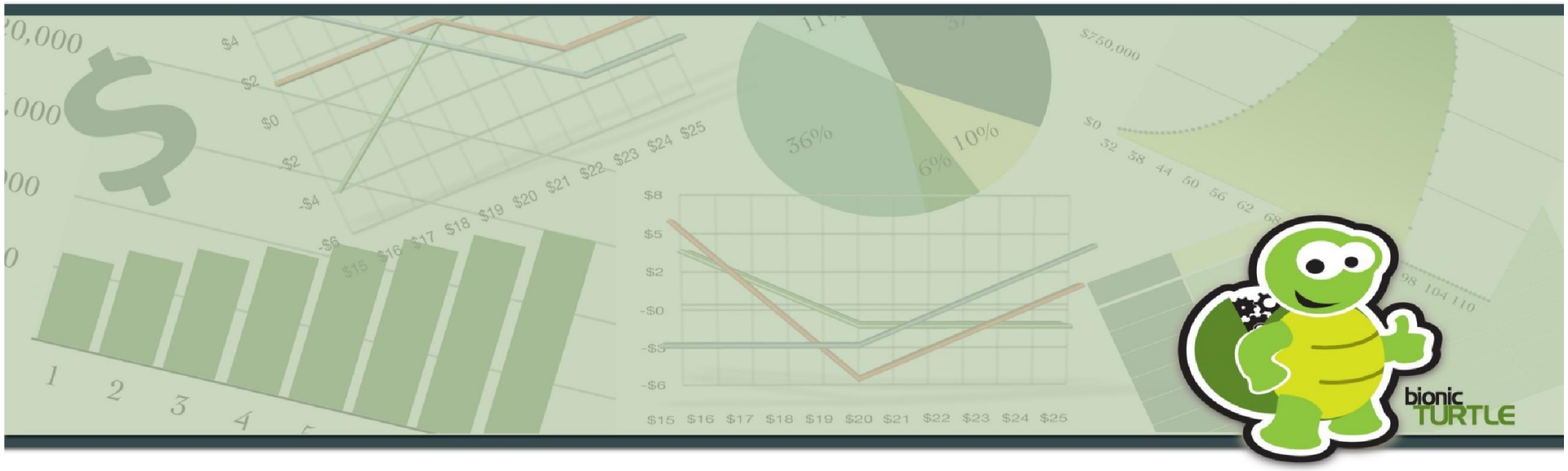


P1.T3. Financial Markets & Products

Hull, Risk Management and Financial Institutions,

Insurance Companies and Pension Plans

Bionic Turtle FRM Video Tutorials

By David Harper, CFA FRM

BIONIC TURTLE

Insurance Companies and Pension Plans

- Describe the key features of the various categories of insurance companies and identify the risks facing insurance companies.
- Describe the use of mortality table and calculate premium payment for a policy holder.
- Calculate and interpret loss ratio, expense ratio, combined ratio, and operating ratio for a property casualty insurance company.
- Describe moral hazard and adverse selection risks facing insurance companies, provide examples of each, and describe how to overcome the problems.
- Distinguish between mortality risk and longevity risk and describe how to hedge these risks.
- Evaluate the capital requirements for life insurance and property-casualty insurance companies.
- Compare the guaranty system and the regulatory requirements for insurance companies with those for banks.
- Describe a defined benefit plan and a defined contribution plan for a pension fund and explain the differences between them.

Describe the key features of the various categories of insurance companies and identify the risks facing insurance companies.

Life insurance companies offer products that provide a payoff when the life of a policyholder is at risk which implies the event of death of a policyholder.

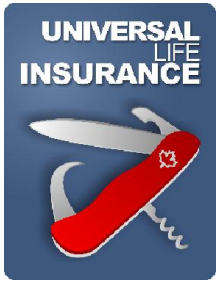
Terrn life insurance: pays only if the policyholder dies during certain period.

Whole life insurance provides protection for the life of the policyholder, so it provides a payoff on the death of the insured, regardless of when it happens.

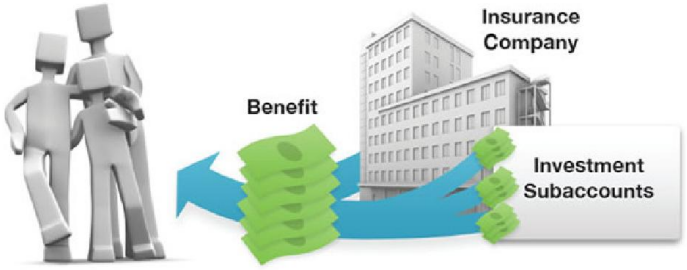
Variable Life Insurance: the surplus premiums are invested in a fund chosen by the policyholder; e.g., equity, bond, or money market fund.

BIONIC TURTLE

Describe the key features of the various categories of insurance companies and identify the risks facing insurance companies.



Universal Life: the policyholder can reduce the premium down to a specified minimum without a lapse in coverage.



Variable-Universal Life Insurance: the policyholder can choose between a number of alternatives for the investment of surplus premiums.

Endowment Life Insurance: lasts for a specified period and pays a lump sum when the policyholder dies or at the end of the period, whichever is first.

Group Life Insurance: covers several people under a single policy and is often purchased by a company for its employees.

BIONIC TURTLE

Describe the key features of the various categories of insurance companies and identify the risks facing insurance companies (continued)

Property-casualty insurance companies: can be subdivided based on their concentration of activities in either property insurance and casualty insurance.

- ***Property insurance*** provide protection against loss of or damage to property from accidents, fire, theft, water damage, etc.
- ***Casualty insurance*** provides protection to individuals and companies against legal liability exposures.

  - ❑ Contracts usually last for a year, but they may be renewed every year.
  - ❑ Premiums collected may change.
  - ❑ The contracts whose payouts are difficult to predict are those where a specific event is liable to trigger claims by many policyholders around the same time.
  - ❑ A property-casualty insurance company must keep more equity capital as a percent of total assets, than a life insurance company.

BIONIC TURTLE

Describe the key features of the various categories of insurance companies and identify the risks facing insurance companies (continued)

Health insurance companies

Health insurance premiums resemble life insurance premiums when changes to the company's assessment of the risk of a payout do not lead to an increase in premiums.

Companies providing pension plan

Many companies provide insurance to employees in the form of a guaranteed income for the rest of their lives once they have retired. Both the company and its employees make regular monthly contributions to the plan and the funds in the plan are invested to provide income for retirees.

BIONIC TURTLE

Describe the key features of the various categories of insurance companies and identify the risks facing insurance companies (continued)

Risks facing insurance companies

- The reserves held by the insurance companies to meet the payouts as required by the claims of policyholders may fall short of their estimation. This is the biggest risk faced by the insurance companies.
- They mostly invest in corporate bonds and when defaults on corporate bonds increase, it takes a toll on the profitability of the insurance company.
- They face liquidity risks associated with their investments. Illiquid bonds give higher yields but they cannot be readily converted into cash to meet high claims when they are not anticipated beforehand.
- Since insurance companies enter into transactions with banks and reinsurance companies, they are exposed to credit risk.
- They are exposed to operational risks and business risks.

BIONIC TURTLE

Describe the use of mortality table and calculate premium payment for a policy holder.

Mortality Table

	Male			Female		
Exact age	Cond'l Death Prob (a)	Cumul Survival Prob (b)	Life Expect	Cond'l Death Prob (a)	Cumul Survival Prob (b)	Life Expect
0	0.006519	1.000000	76.28	0.005377	1.000000	81.05
1	0.000462	0.993481	75.78	0.000379	0.994623	80.49
2	0.000291	0.993022	74.82	0.000221	0.994246	79.52
3	0.000209	0.992733	73.84	0.000162	0.994026	78.54
4	0.000176	0.992526	72.85	0.000133	0.993865	77.55
5	0.000159	0.992351	71.87	0.000119	0.993733	76.56
6	0.000146	0.992193	70.88	0.000109	0.993615	75.57
7	0.000133	0.992048	69.89	0.000101	0.993507	74.58
8	0.000118	0.991916	68.90	0.000096	0.993406	73.58
9	0.000102	0.991799	67.90	0.000093	0.993311	72.59
10	0.000091	0.991698	66.91	0.000094	0.993218	71.60
11	0.000096	0.991608	65.92	0.000100	0.993125	70.60
12	0.000128	0.991513	64.92	0.000112	0.993026	69.61
13	0.000195	0.991386	63.93	0.000134	0.992915	68.62
14	0.000288	0.991192	62.94	0.000162	0.992782	67.63
...	...	...	...	...	...	...
89	0.151299	0.208964	4.34	0.118513	0.330175	5.17
90	**0.167291**	0.177348	4.03	0.132206	0.291045	4.80
91	0.184520	0.147679	3.74	0.147092	0.252567	4.45
92	0.202954	0.120430	3.47	0.163154	0.215416	4.13

BIONIC TURTLE

Describe the use of mortality table and calculate premium payment for a policy holder.

Mortality tables are used to value life insurance contracts.

Calculating premium payment for a policyholder

- *Example*: If the interest rates for all maturities are given as 4% per annum (with semiannual compounding) and premiums are paid once a year at the beginning of the year, **what is an insurance company's break-even premium for $100,000 of term life insurance for a man of average health aged 90?**
- If the term insurance lasts one year, the expected payout is calculated as probability of death multiplied the insurance coverage. For a man aged 90, from the mortality table, it is calculated to be $16,729 and is shown as: $0.167291 \times 100{,}000 = 16,729$.
- In case the payout happens in the middle of the year, then the premium discounted for six months (at the semiannual rate of 2%) is $16,421 and can be calculated as:

$$\frac{16{,}729}{1.02} = 16{,}401$$

BIONIC TURTLE

Describe the use of mortality table and calculate premium payment for a policy holder.

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92	0.202954	0.120430	3.47	0.163154	0.215416	4.13

BIONIC TURTLE

Describe the use of mortality table and calculate premium payment for a policy holder (continued)

- Suppose if the term insurance lasts two years, the present value of expected payout in the first year is $16,729, same as before. The probability that the policyholder dies during the 2nd year is $(1 - 0.167291) \times 0.184520 = 0.153651$. So, the expected payout will be $15,365 and is calculated as: $0.153651 \times 100{,}000 = 15{,}365$
- If the payout happens in the middle of the 2nd year (i.e. in 18 months), then the present value of the payout is $14,478, calculated as:

$$\frac{15{,}365}{(1.02^3)} = 14{,}478$$

- So, the total present value of payouts is $30,880, which is calculated by adding the payout in the middle of the first and the middle of the second year: $16{,}401 + 14{,}478 = 30{,}880$

Now we will move on to calculating the premium payments.

Describe the use of mortality table and calculate premium payment for a policy holder (continued)

- The first premium is required at time zero (age 90), so it is certain that this will be paid. The probability of the second premium payment being made at the beginning of the second year is the probability that the man does not die during the first year. It is calculated as: $(1 - 0.167291) = 0.832709$
- If the premium is X dollars per year, the present value of the premium payments is given as:

$$X + \frac{0.832709X}{(1.02^2)} = 1.800374X$$

The break-even annual premium is calculated by finding the value of (X) by equating the present value of the expected premium payments to the present value of the expected payout: $1.800374X = 30{,}880$

Solving this, we get the value of X as: $\frac{30{,}880}{1.800374} = 17{,}151$

The break-even premium payment is therefore $17,151.

BIONIC TURTLE

Calculate and interpret loss ratio, expense ratio, combined ratio, and operating ratio for a property casualty insurance company.

- ***Loss ratio*** is the ratio of payouts made to premiums earned in a year by an insurance company. In the US, loss ratios are in the 60% to 80% range and have shown an increasing trend over time.

The ***expense ratio*** for an insurance company is the ratio of expenses to premiums earned in a year. Expense ratios in the US are in the 25% to 30% range and have shown a decreasing trend through time.

- The ***combined ratio*** is the sum of the loss ratio and the expense ratio. For example, for a category of policies in a particular year, if the loss ratio is 75% and the expense ratio is 30%, then the combined ratio is 105%.

- If the dividend paid to policyholders is added, we obtain the ***combined ratio after dividends*****.** In our example, suppose a small dividend to the tune of 1% of premiums is paid to the policyholders, we get a combined ratio after dividends of 106%.

BIONIC TURTLE

Calculate and interpret loss ratio, expense ratio, combined ratio, and operating ratio for a property casualty insurance company (cont)

***Operating** ratio* is the ratio obtained when investment income earned from premiums is reduced from the losses as represented by the combined ratio.

- Continuing with the example, our combined ratio after dividends was 106%, which means the insurance company makes a loss of 6% before tax on the policies being considered. If the investment income is 9% of premiums received. Then, the operating ratio would be 106 − 9 = 97%.

Example: Calculation of Operating Ratio for a Property-Casualty Insurance Company

Loss ratio	75%
Expense ratio	30%
Combined ratio	105%
Dividends	1%
Combined ratio after dividends	106%
Investment income	-9%
Operating ratio	97%

BIONIC TURTLE

Describe moral hazard and adverse selection risks facing insurance companies, provide examples of each, and describe how to overcome the problems.

Moral hazard is the risk that availability of insurance would cause the policyholders to behave differently than they would without the insurance. This difference in behavior increases the risks and the expected payouts of the insurance company.

Examples moral hazard are:

- A car owner buys insurance to protect against the car being stolen. Due to insurance, he or she becomes less likely to lock the car.
- An individual purchases health insurance. As a result of the existence of the policy, more health care is demanded than previously.
- As a result of a government-sponsored deposit insurance plan, a bank takes more risks because it knows that it is less likely to lose depositors because of this strategy.

BIONIC TURTLE

Describe moral hazard and adverse selection risks facing insurance companies, provide examples of each, and describe how to overcome the problems (continued)

By aligning the interest of the policyholders more closely with those of the insurance company, moral hazard can be handled better, as explained by using the following methods:

Deductibles: The policyholder is responsible for bearing the first part of any loss.

***Co-insurance provision*:** The insurance company pays a predetermined percentage (less than 100%) of losses in excess of the deductible.

Policy limit: An upper limit to the payout is set by the insurance company.

BIONIC TURTLE

Describe moral hazard and adverse selection risks facing insurance companies, provide examples of each, and describe how to overcome the problems (continued)

Adverse selection occurs when an insurance company cannot distinguish between good and bad risks and as a result it offers the same price to everyone, thereby attracting more of the bad risks.

Examples for adverse selection are:

- If an insurance company is not able to distinguish good drivers from bad drivers and offers the same auto insurance premium to both, it is likely to attract more bad drivers.
- If it is not able to distinguish healthy from unhealthy people and offers the same life insurance premiums to both, it is likely to attract more unhealthy people.

To reduce the impact of the problems created due to adverse selection, an insurance company tries to do more research about the policyholder before committing itself.

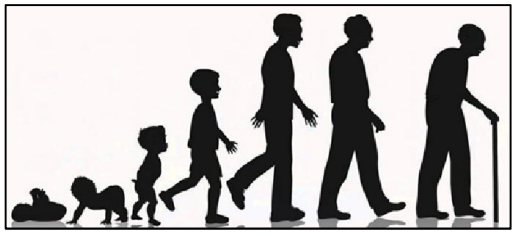
BIONIC TURTLE

Distinguish between mortality risk and longevity risk and describe how to hedge these risks.

Mortality risk is the risk that wars, epidemics such as AIDS, or pandemics such as Spanish flu will cause individuals to die sooner than expected.

- Increase in mortality adversely affects life insurance contracts because the insured amount may have to be paid earlier than expected.
- In calculating the impact of mortality risk, it is important to consider the age groups within the population that are most affected by an event.

Longevity risk is the risk that advances in the field of medicine and healthy lifestyle options will cause people to live longer.



- Increase in longevity causes the final payout to be either delayed or, in the case of term insurance, less likely to happen in case of life insurance contracts and so it mostly increases their profitability.
- Increases in longevity adversely affects the profitability of most types of annuity contracts as the annuity has to be paid for longer.

BIONIC TURTLE

Distinguish between mortality risk and longevity risk and describe how to hedge these risks (continued)

Hedging mortality and longevity risk

- The longevity and mortality risks in the annuity side of an insurance company tend to neutralize those present in its regular life insurance contracts. When the net exposure of the insurance companies is large, the option of reinsurance is considered. ***Reinsurance*** is one way in which an insurance company can hedge itself against large losses by entering into contracts with another insurance company. By paying a premium, the company transfers some of its risks to the other insurer.
- Insurance companies may enter in to a ***longevity derivative contract*** that provides payoffs favorable to them when they are concerned about their longevity exposure on annuity contracts.
  - A population group is defined and the coupon on the bond at any given time is defined as being proportional to the number of individuals in the population that are still alive.
  - Speculators sell these bonds to insurance companies. Speculators are willing to take this risk as these bond payments are largely uncorrelated with market returns.

BIONIC TURTLE

Evaluate the capital requirements for life insurance and property-casualty insurance companies.

The table below shows the summary of the balance sheet for a **life insurance** company. The insurance company has exposure on liability and asset sides of balance sheet. The company tries to match the maturity of its assets with the maturity of liabilities. In this process, it takes on credit risk because the default rate on the bonds may be higher than expected.

Abbreviated Balance Sheet for Life Insurance Company

Assets		**Liabilities and Net Worth**	
Investments	90.0	Policy reserves	80.0
Other Assets	10.0	Subord Long-term Debt	10.0
		Equity Capital	10.0
Total	**$100.0**	**Total**	**$100.0**

The policy reserves (80% of assets in this case) are conservative estimates of the present value of payouts on the policies that have been written. If the holders of life insurance policies die earlier than expected or the holders of annuity contracts live longer than expected, then actual payouts would be higher than the estimates.

BIONIC TURTLE

Evaluate the capital requirements for life insurance and property-casualty insurance companies (continued)

The table below shows the summary of balance sheet for a **property-casualty insurance** company. The payouts required are uncertain and less easy to predict as they are influenced by natural disasters or liabilities related problems. Hence the risks associated with their business is higher. So, the equity required is higher than that for life insurance companies.

Abbreviated Balance Sheet for Property-Casualty Insurance Company

Assets		**Liabilities and Net Worth**	
Investments	90.0	Policy reserves	45.0
Other Assets	10.0	Unearned premiums	15.0
		Subord Long-term Debt	10.0
		Equity Capital	30.0
Total	**$100.0**	**Total**	**$100.0**

Compare the guaranty system and the regulatory requirements for insurance companies with those for banks.

Guaranty System

Insurance guaranty associations protect the policyholder against the risks of an insurance company being unable to make payouts on claims when they become insolvent. In order to obtain a license to conduct an insurance business, an insurer is required to become a member of the guaranty association in a state. Every insurance company operating in the state contributes an amount to the state guaranty fund depending on the premium income it collects. When an insurance company becomes insolvent, this fund is used to pay the small policyholders of that company.

Compare the guaranty system and the regulatory requirements for insurance companies with those for banks (continued)

Regulatory requirements

In the United States, insurance companies are regulated at the state level rather than at the federal level whereas banks are regulated at the federal level.

The state level regulators are involved with issues such as the solvency of insurance companies, their ability to satisfy policyholders' claims and also their business conduct which deals with how premiums are set, advertising, contract terms, the licensing of insurance agents and brokers etc.

Regulation of insurance companies at the state level faces some shortcomings as mentioned below.

- **Regulations tend to vary across different states.**
- **Some insurance companies trade derivatives in the same way as banks, but are not subject to the same regulations as banks which can lead to some serious issues.**

BIONIC TURTLE

Compare the guaranty system and the regulatory requirements for insurance companies with those for banks (continued)

- **The Dodd–Frank Act of 2010 in the US** resulted in the formation of ***Federal Insurance Office (FIO)*** which monitors the insurance industry and identifies gaps in regulation. According to a report submitted by the FIO to the Congress in 2013 to improve the US insurance regulation, it was suggested that the United States will either (a) move to a system where regulations are determined federally and administered at the state level or (b) move to a system where regulations are set federally and administered federally.

- **In the European Union**, insurance companies are regulated centrally implying similar regulatory framework across all member countries. This framework known as ***Solvency I*** was based on research which showed that, with a capital equal to 4% of policy provisions, life insurance companies have a 95% chance of surviving. Solvency I does not consider investment risks, and to overcome such weaknesses the European Union is working on Solvency II. ***Solvency II*** assigns capital for a wider set of risks than Solvency I.

BIONIC TURTLE

Describe a defined benefit plan and a defined contribution plan for a pension fund and explain the differences between them.

Defined contribution plan

- In a defined contribution plan, the contributions to the plan are defined, and the employer and employee contributions are invested on behalf of the employee. When employees retire, the final value of the contributions invested can be converted to a lifetime annuity or received as a lump sum.

Defined benefit plan

- In a defined benefit plan, regular contributions are required up to a certain age and then lifetime pensions are provided. The pension to be received by the employee after retirement is defined by a plan. The pension is calculated by a formula which is based on the number of years of employment and the employee's salary.

BIONIC TURTLE

Describe a defined benefit plan and a defined contribution plan for a pension fund and explain the differences between them (continued)

- In a **defined benefit plan**, the benefits to be received by the employee are defined, but in a **defined contribution plan**, the monthly contributions to be made by the employees and employers to the pension plan are defined.
- In a **defined benefit plan**, the contributions to the pension fund are all pooled and payments to retirees are made out of the pool. In a **defined contribution plan**, the funds are identified with individual employees which means that for each employee a separate account is set up and the pension is calculated only from the funds contributed to that account.
- The most important difference between the two plans is that while the responsibility of the **defined benefit plans** lies with the employer, the responsibility of the performance of a **defined contribution plan** is left in the hands of the employee.

BIONIC TURTLE

The End

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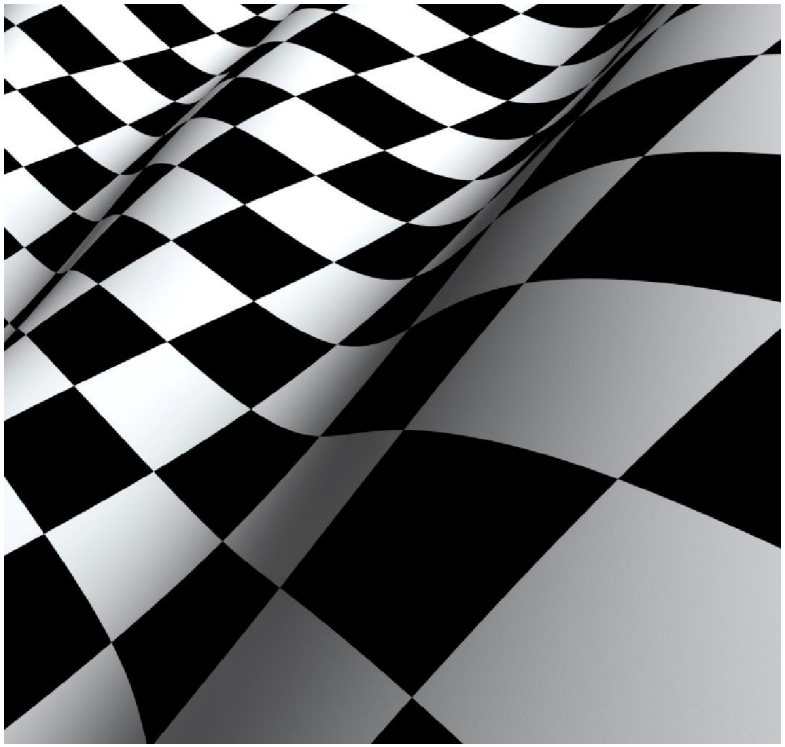
Insurance Companies and Pension Plans



BIONIC TURTLE