

Space insurance market

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Introduction

Nowadays, insurance is playing big role in the space projects, because it secures the financial stability of the companies and it is considered to be the second main cost in the projects. It is important to notice, that insurers clearly divide space insurance market on two segments: launch insurance and in-orbit insurance.

The main issue with space insurance is that the market is very volatile. And sometimes the budget projection made by space industry players (producers, operators, etc.) for their project several years before, can not withstand current rates. So it is important to understand how space insurance market works and what the main factors are, which play a significant role in the dynamic of that market, and make predictions.

The present study will discuss the historical evolution of space insurance market; analysis of the data, for determination of key parameters; quantitative and qualitative analysis of key parameters and inter connection of parameters; as well as discuss the present trends of the market.

The Chapter 1 will consider the analysis of historical data and the choice of parameters for further study. After that, Chapter 2 will describe the quantitative and qualitative analysis of the data. The Conclusions chapter will describe the key findings and prediction for the market.

Chapter 1: Market overview 1989-2008

The first chapter describes historical data and provides background necessary for further analysis. Losses¹ sequence, evolution of the market, behavior of the market players, reliability statistics and key events will be analyzed in the following chapter. Historical data is divided on two periods: 1989-2003, 2004-2008. The reason for this is the precision of data available and the different situations on the market, which were present during these periods. I also want to mention, that the information before 1989 could not be used in analysis, because only in 1988 the number of insured launches exceeded the critical mass, namely the space insurance start to make profit (Smirnov, I. 2004).

During the period from 1989 to 2003, major market crisis of 1998-2001 could be observed: significant unprofitability of in-orbit segment, as well as three crisis years for launch industry (1994, 1998 and 2001) led to hard market conditions in the end of the period. Reduction of the number of commercial launches and failure of communication constellation projects (Teledesic (NGSO), Ecco (NGSO), etc.), also made a significant influence on the space insurance market during this period by reduction of planned (projected) premium. (See Figure 1 below) (FAA 2007, Smirnov, I. 2004)

During the period from 2003-2008, the recuperation of the market could be seen, however there were still some reactions to the crisis that took place in 1998-2001. In the end of period, the market conditions became softer, the number of launches started to increase (Mostly because of periodical replacement of in-orbit assets approximately every 10 years).

All these data will be considered in the following chapters in detail.

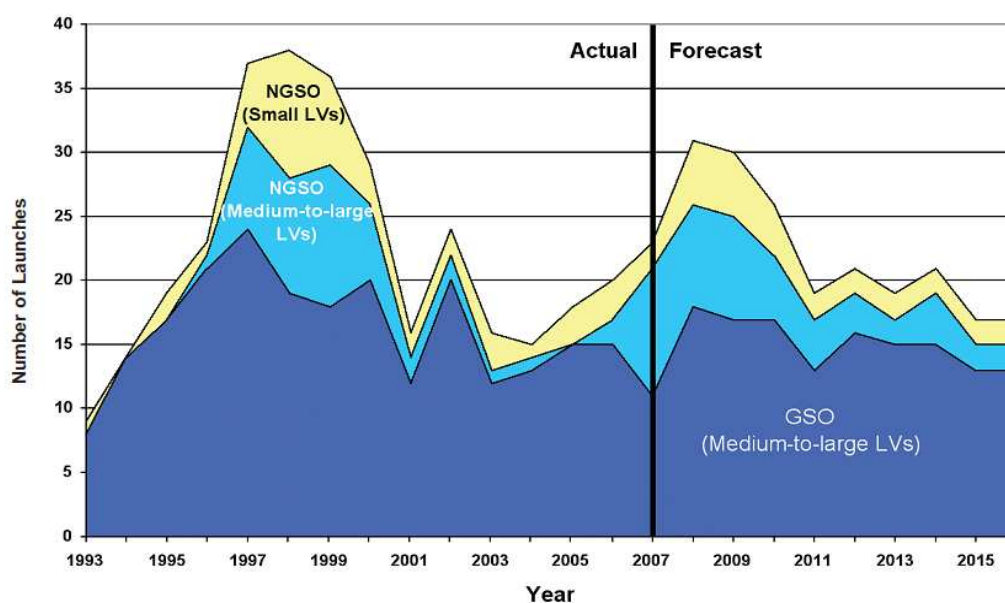


Figure 1 Commercial Orbital Launch Forecast (1993-2016)² (FAA 2007)

¹ Losses- paid claims for reimbursement either for whole market or for launch and in-orbit market segments. It is calculated as sum of all losses for each particular year.

² Abbreviations from Figure 1 Commercial Orbital Launch Forecast (1993-2016) (FAA 2007): GSO- Geo Stationary Earth Orbit; NGSO- non Geo Stationary Earth Orbit; LVs- Launch Vehicles

1.1 International Space insurance market 1989-2003

The market of launch insurance in the end of period from 1989 to 2003 had a positive net result (Approximately \$1.2B³). But the years 1994, 1997-1998, and 2000-2001 had significant losses. On the diagram below, the net result for each year and accumulated net result for launch insurance is shown. The Figure 2 illustrates that the crisis of 1998 and 2001 made a significant contribution to the decrease of accumulated net result, collected in the previous years. Accumulated net result is calculated, hereinafter, as the sum of net results starting from the year 1989. (Medvedchikov, D. 2008)

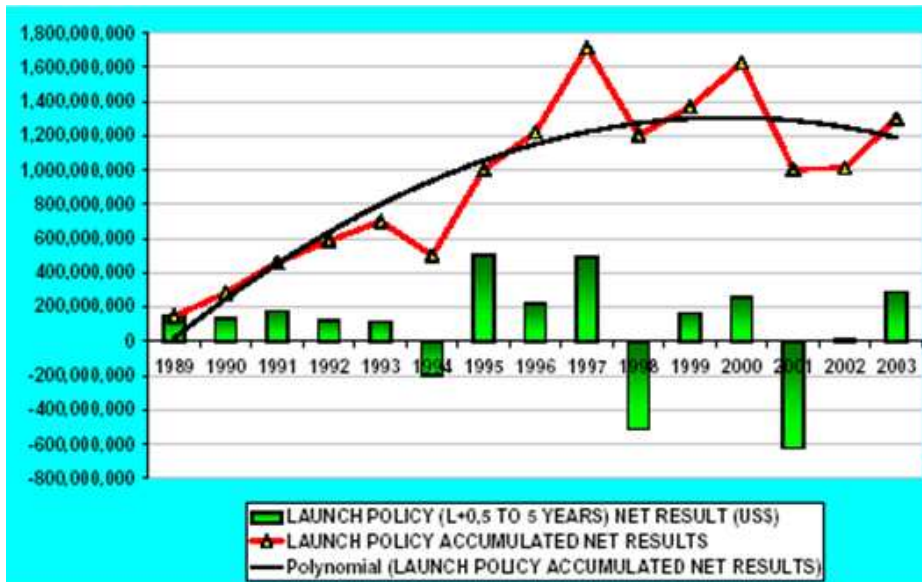


Figure 2 Launch and First year In-orbit Operation Net Result (Medvedchikov, D. 2008)

At the same time, the market of in-orbit insurance had a 7 out of 10 years with negative net result and ended up in the year 2003 with a negative accumulated net result of \$800M of losses. It can be easily seen on the following diagram that starting from year 1995 insurers had a negative accumulated net result, even though they came to a positive result (profit zone) in the year 1994 after 4 years (1991-1994) without significant losses (Medvedchikov, D. 2008):

³ Note that all the monetary data in the report, given in US Dollars of 2008 FY

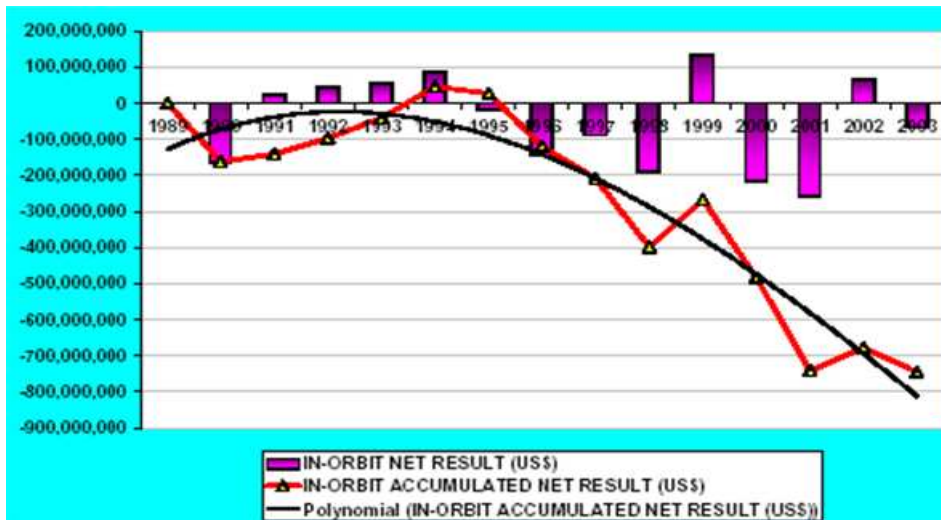


Figure 3 In-orbit Net Result (Medvedchikov, D. 2008)

It is important to know, what the key conditions led to such situation. The history shows, that during the evolution of the space insurance market, there were only three common market trends, which will be discussed in the following paragraph.

As it was mentioned before, the space insurance market gained the critical mass in the 1989, and this was the year when shareholders of the insurance companies started to ask the question: “How much money space segment can bring in profit?” Up to 1997, the forecast was approximately \$150-170M per annum. It was an aggressive, but achievable result. To achieve such a result insurers increased the insurance capacity⁴, which increased the competition and drove the rates down. But, the years 1994-1997 showed, that space insurance market can bring catastrophic losses (up to several Billion US Dollars). So the new trend of insurance market was more conservative. The planned profit was set down to \$70-80M per annum, but the market already gained the enormous capacity of \$1.2-1.3B for one launch (mostly because of promising forecast of profit \$150-170M per annum). With such competitive situation, the rates were still going down. In the years 1998-2001 market got enormous losses, both in launch and in-orbit segments, which lead to decreasing capacity and increasing rates, which was the new market trend. (Smirnov, I. 2004, Medvedchikov, D. 2008)

1.2 International Space insurance market 2003-2009

So in the end of 2002 the market was in the weak position. Growth of rates, sensitivity to losses, hard policy conditions and requirements were the main characteristics of space insurance market. Also big influence was made by decreasing of spacecrafts reliability, which is illustrated in the Table 1. Key events and evolution of market will be discussed in detail. (Medvedchikov, D. 2008)

⁴ Insurance capacity represents the monetary amount available to cover one event (risk). For market it is the aggregate of all capacities that underwriters individually allocate to space activities. (De Dinechin, G. 2008)

2003

This year brought a big number of unpleasant events, including tragedy with STS Shuttle Columbia, 15 GEO satellites malfunction, two damages of satellites during the manufacturing and explosion of VLS-1 LV in Brazil (loss of property for \$6.5B). On the insurance market, however, it brought an improvement of the situation compared to the year 2002: insurers got \$717M in premium⁵ and paid \$409M of losses. But the numerous losses of in-orbit spacecrafts couldn't be unnoticeable, so the market remained its hard conditions: high rates (18-30% for launch insurance and 2.7-3.7% for in-orbit insurance); relatively low capacity (\$250M for launch insurance and \$150-200M for in-orbit insurance), which caused incomplete deployments of risks; constructive total loss was 75% of satellite capabilities; exclusion of serial losses (because of Boeing 702 case); a lot of insurers left the space insurance market. (Medvedchikov, D. 2008)

2004

Unfortunately, the situation with the events became even worse in 2004: 9 GEO satellites malfunction, explosion and fire on the launch pad in India, suits with Boeing Company (702 Bus), 2 partial launch failures (too low perigee). As the result of all events and unpleasant sequence of rich for events years (especially for in-orbit insurance), the space insurance market became uncompetitive (mostly because of extremely big rates). Conditions became even harder: the coverage period was reduced to 6 month after the launch and the insurance terms were divided on two stages (launch and in-orbit stages). Rates were still growing on 30-50% compared to year 2003, and were 18.9-30% for launch insurance and 2.7-3.9% for in-orbit insurance. Also market capacity was reduced on 10% compared to FY 2003, which was \$300 Millions. Such reduction led market to a further growth of the rates for the full coverage in the end of year.

Such an alarming situation in the market led to a hardening of conditions on the market in the end of year: reduction of the coverage period to 180 days after launch, introduction of deductible for full loss (constructive or total) as well as partial loss, low market capacity and increasing insurance rates. (Medvedchikov, D. 2008)

2005

There were 19 successful insured launches in the year 2005. In the end it gave the insurers \$858M of premium and only \$85M of claims paid. Additionally the losses for the amount of \$108M from the previous years were paid (Estrela Do Sul, Superbird-16 and the others). So the world income of the insurers was \$655 Millions. Such positive trend, led to a "softer" market, with a bigger capacity (\$411M). The rates for launch insurance started the reduction, but for in-orbit insurance rates stayed stable. (Medvedchikov, D. 2008)

2006

In 2006 the same positive trend as in the FY 2005 continued. The result was the expansion of market capacity. 21 launches were insured. Four claims were announced, biggest of them was Arabsat-4A, which failed to reach its' intended orbit, during the Proton-M launch (Claim for \$179.2M).

⁵ In this report, the term premium means the sum of all premiums collected by market players for each particular year.

On the 12th of January “mega” capacity for in-orbit exploitation was announced: syndicate Liberty and Sciemus Company, suggested capacity of \$250 Millions for each risk, which could be expanded up to \$400 Millions. Such capacity was available through LibSat consortium. For risk estimation they used expertise of QinetiQ Company and its statistic models.

As the capacity was expanded during these two positive years, insurers started to lower the rates down from 19-20% in the beginning of 2005 to 15% in June 2006 for launch insurance, and down to 2.35% for in-orbit insurance.

On the graph below you can see the evolution of insurance rates from 1989 to 2006 for “launch+1 year in-orbit” risk, where red line shows polynomial average insurance rate and dotted lines shows the distribution of rates:

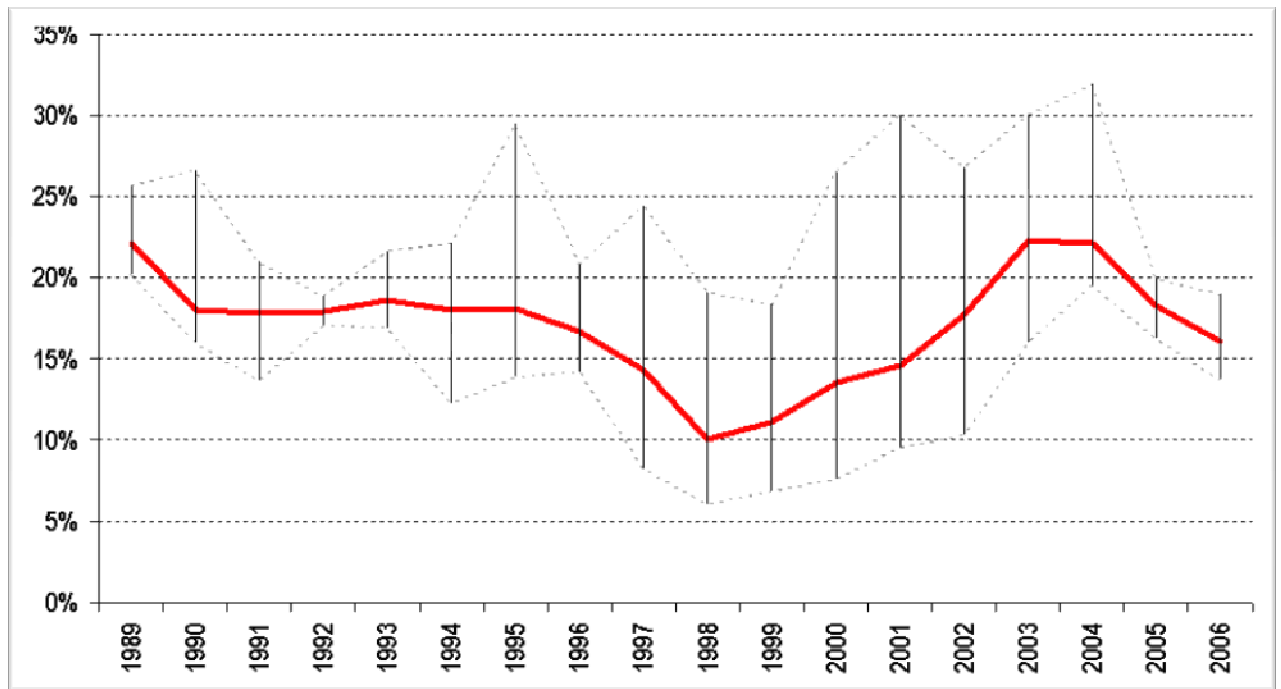


Figure 4 Evolution and distribution of rates for launch insurance (1989-2006) (Smirnov, I. 2006)

In 2006 the market had a positive trend of lowering the rates, increasing competition (bigger capacity) and increasing number of launches. The market just recovered from 1998-2001 crisis. The launch and in-orbit insurance were continuously dividing the market on two segments, and if launch insurance had a positive trend of premium accumulation, the in-orbit market was in stagnation.

It is really interesting to see the distribution of failures on the insurance period, which appear in the following table:

Years	Satellites losses during different lifetime phases (%)		
	Launch period	180 days after launch	More than 180 days after the launch
1990-1995	75	17	8
1996-2006	35	33	32

Table 1 Distribution of losses on insurance coverage periods (%). Data source: Medvedchikov, D. 2008

It can be seen, that in the period of 1996-2006 the distribution of losses became more uniformed, compared to the period from 1990 to 1995 when the launch industry was bringing 75% of all losses. This shows, that during the period from 1996 to 2006 launch vehicles became more reliable, and spacecrafts less reliable. (Medvedchikov, D. 2008, Smirnov, I. 2006)

2007

The year 2007 brought another two failures of Russian Launch Vehicles (8 failures in 21 month). In January, Zenit-3SL (Sea Launch) had an accident during the launch of NSS-8 satellite, because of 1st stage engine malfunction. Launching pad was also damaged, which led to a change in the launching schedule and caused insurers loss of planned premium. In September JCSAT-11 was destroyed during the failed launch of Proton-M LV.

These failures brought to a market loss, in amount of \$450M out of \$610M of paid premium. Also malfunction of ORBVIEW 3 satellite (\$40M) and RASCOM satellite (\$236M) increased the losses up to \$726M. So the year ended with negative net result of \$116 Millions. (Medvedchikov, D. 2008)

2008

The space insurance market ended the year 2008 in a profit position: premiums were above \$900M, estimated claims were \$397M. In the first half of the year launch market experienced some hardening in response to losses (Proton-M launch failure with AMC 14 satellite, \$182M), but in the second half the market has been stabilized: competitive rates and terms were available for attractive risks, differentiation of launch vehicles and platforms were measurable. In-orbit insurance generally reduced rates on 5 to 10%, differentiation of platforms and health status remained measurable. (De Dinechin, G. 2009, ISB 2008)

1.3 Chapter conclusions

In the previous chapters the evolution of insurance market was considered. Now, it is relevant to determine the market trend and key factor for the period from 2003-2008, as the trends for previous years have been addressed (Page 5). As can be seen from historical overview, the market is mostly sensitive to the profitability level, so for further analysis the ratio between losses and premium (aggregate (annually) for the whole market) was chosen to be investigated as a key parameter. (Fuzik 2008, Timofeeva, 2009) It is important to note, that for the mathematical analysis, losses to premium rate would not be distinguished on the insurance market segments, as the insurers mostly work in the both segments simultaneously, which can be also seen in Figure 5, where the trends for in-orbit and launch insurance market parameters (capacities and rates) remain almost parallel.

The following figure represents the summary of the previous chapter in numerical values starting from 1996 to 2008. To be able to make the analysis of trends on the figures in one scale, the logarithm (Log) values were used in the most of the following figures.

The summary of the data can be seen in Table 3. The table in the figure below represents the logarithm values of this data. Horizontal axis shows the years.

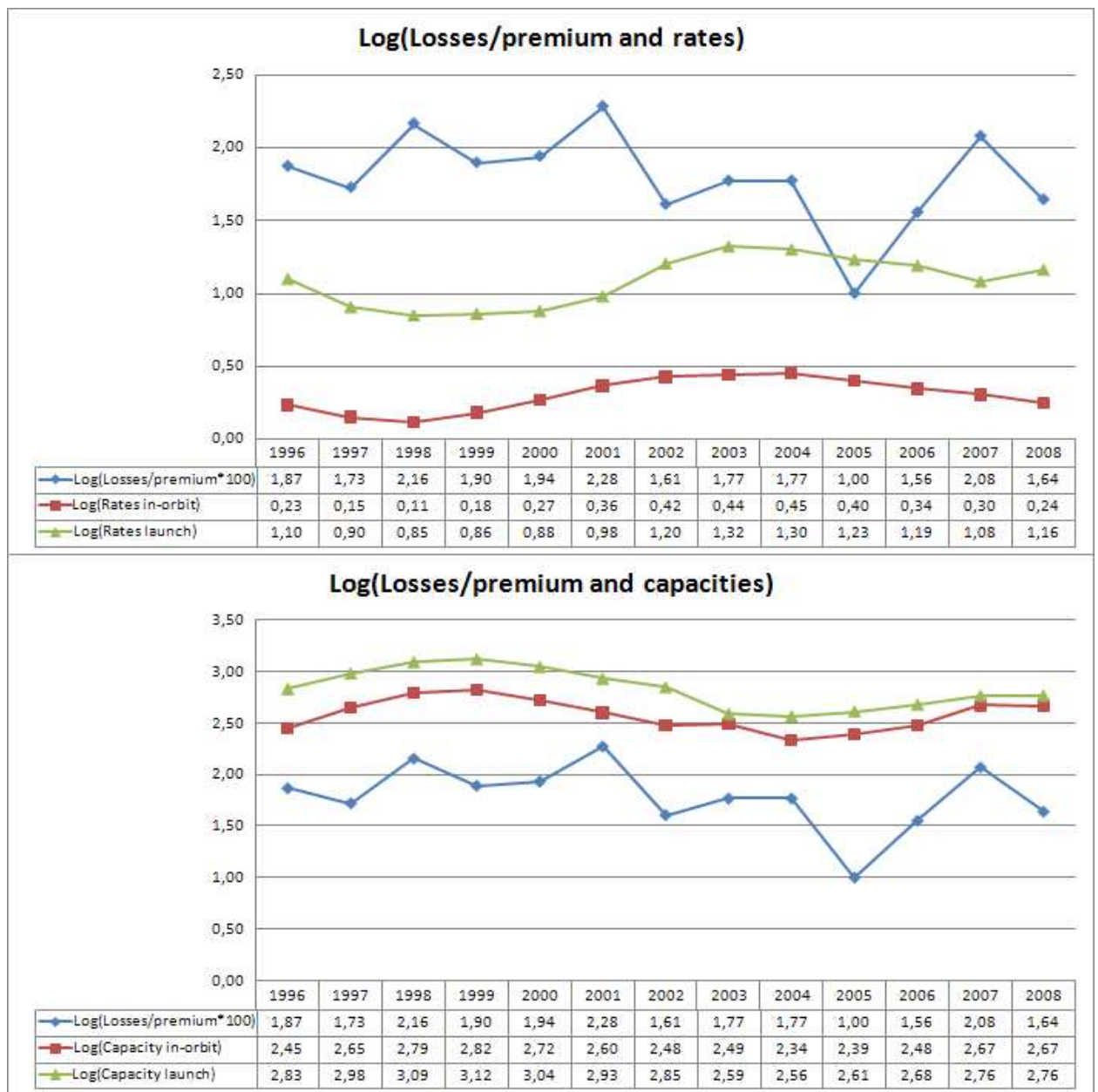


Figure 5 Logarithm values of losses to premium rate with rates and capacities for different market segments. Data source: Medvedchikov, D. 2008

Table 2 illustrates the main definitions which were used in the present report:

Losses	Paid claims for reimbursement either for whole market or for launch and in-orbit market segments. Calculated as sum of all losses for each particular year
Premium	In this report, premium mean the sum of all premiums collected by market players for each particular year
Capacity	Insurance capacity represents the monetary amount available to cover one event (risk). For market it is the aggregate of all capacities that underwriters individually allocate to space activities

Table 2 Definitions table (De Dinechin, G. 2008)

Chapter 2: Data analysis

The following chapter describes the analysis of the data, which was performed to investigate losses to premium rate to be the main contributor to the changes in market conditions. Both, quantitative (2.1 Correlation analysis) and qualitative (2.2 analyses were performed and described in the following chapters.

The most of the data was taken from the summary report by Medvedchikov: Insurance of Space Risks: 2003-2008 (made for International Conference on Space Insurance 2008), where the data was brought to a common standard. For the period from 1996 to 2007 the more precise data is available, that is why it was used in the analysis.

The Chapter 2.1 describes mathematical tests that were performed with data in attempt to quantify the correlation of losses to premium rate with market parameters. Also Chapter 2.2 describes correlation analysis to prove influence of in-orbit insurance market on launch insurance market.

2.1 Correlation analysis

Present chapter describes the use of correlation analysis to determine the relationship between losses to premium rate and market conditions, which represented by insurance capacity and rates. Correlation analysis is a study of relationship between two variables. The objective of correlation analysis is to determine the degree of correlation (relationship) between variables, from zero (no correlation) to perfect (complete) correlation, designated to 1.0. The strength of correlation is not dependant on the direction of correlation (positive or negative). (Mason, Lind and Marchal 1994)

In the first iteration of correlation analysis the losses to premium rate was investigated do give sufficient influence on numerical values of insurance rates and capacities. In the table below you can see data, which have been used for analysis:

Years	Losses/premium	Rates in-orbit (%)	Capacity in-orbit(M\$)	Rates launch (%)	Capacity launch(M\$)
1996	0,7	1,70	280,0	12,5	675,0
1997	0,5	1,40	445,0	8,0	955,0
1998	1,5	1,30	620,0	7,0	1 234,0
1999	0,8	1,50	660,0	7,2	1 316,5
2000	0,9	1,85	530,0	7,5	1 106,5
2001	1,9	2,30	400,0	9,5	852,0
2002	0,4	2,65	300,0	16,0	700,0
2003	0,6	2,75	310,0	21,0	385,0
2004	0,6	2,80	217,0	20	366,0
2005	0,1	2,50	248,0	17	409,0
2006	0,4	2,20	300,0	15,5	475,0
2007	1,2	2,00	470,0	12,0	581,0
2008	0,4	1,75	467,0	14,5	582,0

Table 3 Summary table for use in the first iteration of correlation analysis. Data source: Medvedchikov, D. 2008

The following table illustrates numerical result of correlation analysis. Important to notice, that the sign before the numerical value of correlation degree represents the direction of correlation. Namely, the negative correlation means, that if one of the variables is increasing, the other is decreasing.

Correlation(Losses/Premium to rates in-orbit)	-0,276878159
Correlation(Losses/Premium to rates launch)	-0,55060398
Correlation(Losses/Premium to capacity in-orbit)	0,46815686
Correlation(Losses/Premium to capacity launch)	0,477102163

Table 4 Result of the first iteration correlation analysis. Data source: Medvedchikov, D. 2008

Because, the numerical result of correlation is in average less than 0.5, the analysis conclude, that the relationship between losses to premium rate is moderate to weak. (Mason, Lind and Marchal 1994)

In the following iteration of analysis, the losses/premium rate was tested to be a driver for differences between market conditions in the different years. Changes in market conditions were chosen to be tested to de-trend the data and receive more accurate result.

In the following table the raw data that was used for analysis can be seen (1996-2008):

Losses/premium	Δ for rates in-orbit	Δ for rates launch	Δ for capacity in-orbit	Δ for capacity launch
0,7	0,30	4,5	-165,0	-280,0
0,5	0,10	1,0	-175,0	-279,0
1,5	-0,20	-0,2	-40,0	-82,5
0,8	-0,35	-0,3	130,0	210,0
0,9	-0,45	-2,0	130,0	254,5
1,9	-0,35	-6,5	100,0	152,0
0,4	-0,10	-5,0	-10,0	315,0
0,6	-0,05	1,0	93,0	19,0
0,6	0,30	3,0	-31,0	-43,0
0,1	0,30	1,5	-52,0	-66,0
0,4	0,20	3,5	-170,0	-106,0
1,2	0,25	-2,5	3,0	-1,0
0,4				

Table 5 Summary data for use in the second iteration of correlation analysis. Data source: Medvedchikov, D. 2008

Where (T is years):

$$\Delta \text{ for rates in - orbit}_T = (\text{Rates in - orbit})_T - (\text{Rates in - orbit})_{T+1};$$

$$\Delta \text{ for capacity in - orbit}_T = (\text{Capacity in - orbit})_T - (\text{Capacity in - orbit})_{T+1};$$

$$\Delta \text{ for rates launch}_T = (\text{Rates launch})_T - (\text{Rates launch})_{T+1};$$

$$\Delta \text{ for capacity launch}_T = (\text{Capacity launch})_T - (\text{Capacity launch})_{T+1}.$$

The average result of this test (slightly bigger than 0.54) shows moderate relationship between losses to premium rate and market conditions. The numerical result is illustrated in the table below:

Correlation(Losses/Premium to Δ rates in-orbit)	-0,5079508
Correlation(Losses/Premium to Δ capacity in-orbit)	-0,56148348
Correlation(Losses/Premium to Δ rates launch)	0,39659776
Correlation(Losses/Premium to Δ capacity launch)	0,691443545

Table 6 Result of second iteration correlation computation. Data source: Medvedchikov, D. 2008

As can be seen according to results, if the losses to premium rates are growing up (in worst case, becomes more than 1), changes for rates of in-orbit and launch insurance are going down (becomes negative), which means the growth of insurance rates. In case of capacities, everything is opposite: growing losses to premium rate increases the changes for capacities of in-orbit and launch insurance (which become positive) and decreases the capacity of the market. In both cases market conditions become harder. (Timofeeva, 2009)

As a result of mathematical tests, it can be seen that no strong correlation between data arrays have been determined. So the qualitative analysis, which described in the following chapter, was performed.

2.2 Qualitative analysis

Qualitative analysis was used to analyze the significance of influence of extreme values of losses to premium rate and sun activity on the market conditions. As well as interconnection of space insurance market segments. (Timofeeva, 2009, Smirnov, I. 2005)

To analyze the data more correctly, divided data for two market segments was used. In the following figures you can see logarithmic graphs with losses to premium rates, insurance rates and capacities for in-orbit and launch insurance.

For losses to premium rate, positive (>0) values show us the detrimental years. Red arrows show the trends of market parameters, when it is first year of trend. The data used in the figures is from 1997 to 2008. The reason for the choice of information is the availability of precise information for market segments, which is available only for these particular years.

2.2a In-orbit market analysis

The Figure 6 illustrates the values for losses to premium rate and market conditions for in-orbit insurance market. Table on the figure illustrates numerical (logarithm) values of parameters.

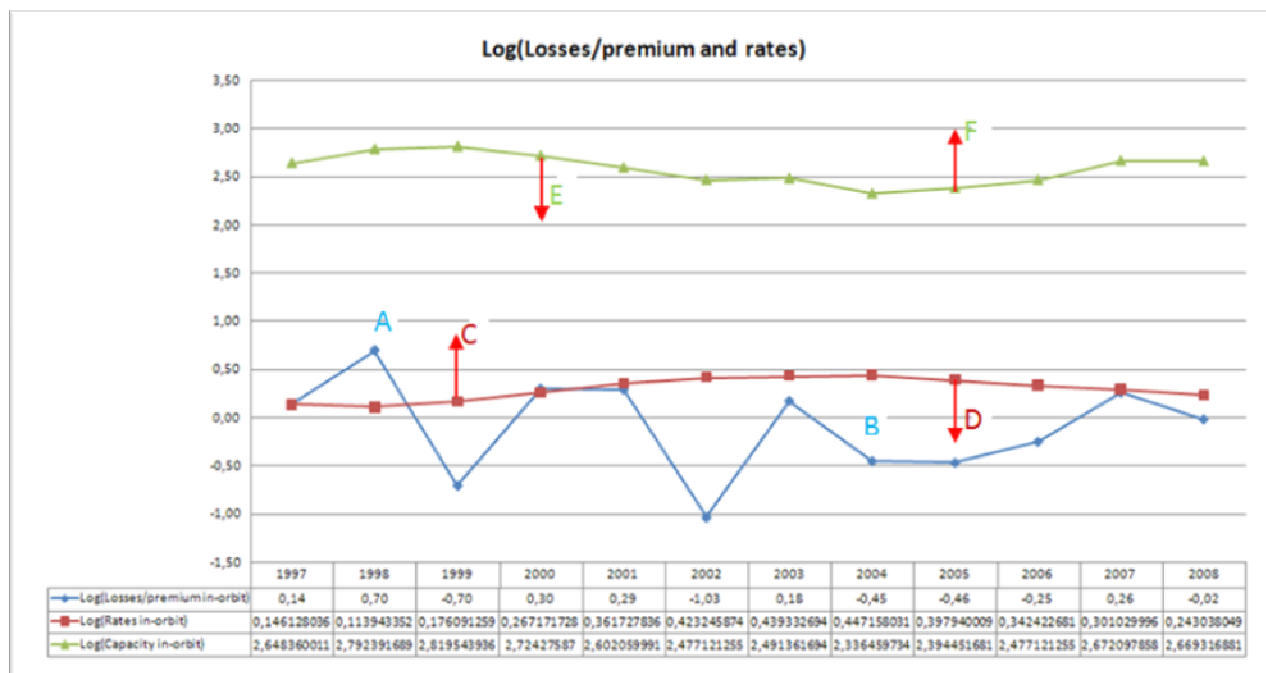


Figure 6 Logarithmic values of losses to premium rate, insurance rates and capacities for in-orbit insurance. Data source: ISB 2008, Medvedchikov, D. 2008

As can be seen, according to the figure above, positive value of logarithmic losses to premium rate (>1 in absolute value) negatively affects the market, by driving rates up and capacities down. In the year 1998 we see positive losses to premium rate (A) which drives the rates up (C) and after the capacity down (E). It is important to note, that the first reaction of insurers on significant losses, is increased rates. After, if the situation remains unstable, some of the players leave partly or fully the space insurance market, which means decreased capacity, and further increase of rates.

When the situation with losses stabilized, which can be seen in 2004 (B), the market start to be more attractive for the insurers, they place bigger capacity, which drives the rates down. Important to notice that after the year 2006 the significant increase of capacity could be seen. The market started to stabilize during this year, which led to increase of leaders' capacity (Swiss RE (+50%), Watkins (+200%), Britt (+50%), as well as introduction of new players. The most significant of which was introduction of "mega" capacity by LibSat Consortium (Page 7). However, some of the market leaders left the market (Generali, QBE, Aviabel, etc.). Nowadays, the situation with losses has stabilized, the rates are well weighted. However, there is still risk of destabilization, in case of significant losses. (Timofeeva, 2009, ISB 2008, De Dinechin, G. 2009, Smirnov, I. 2006)

2.2b Launch market analysis

In the Figure 7 the illustration of launch insurance losses to premium rates and market parameters can be seen.

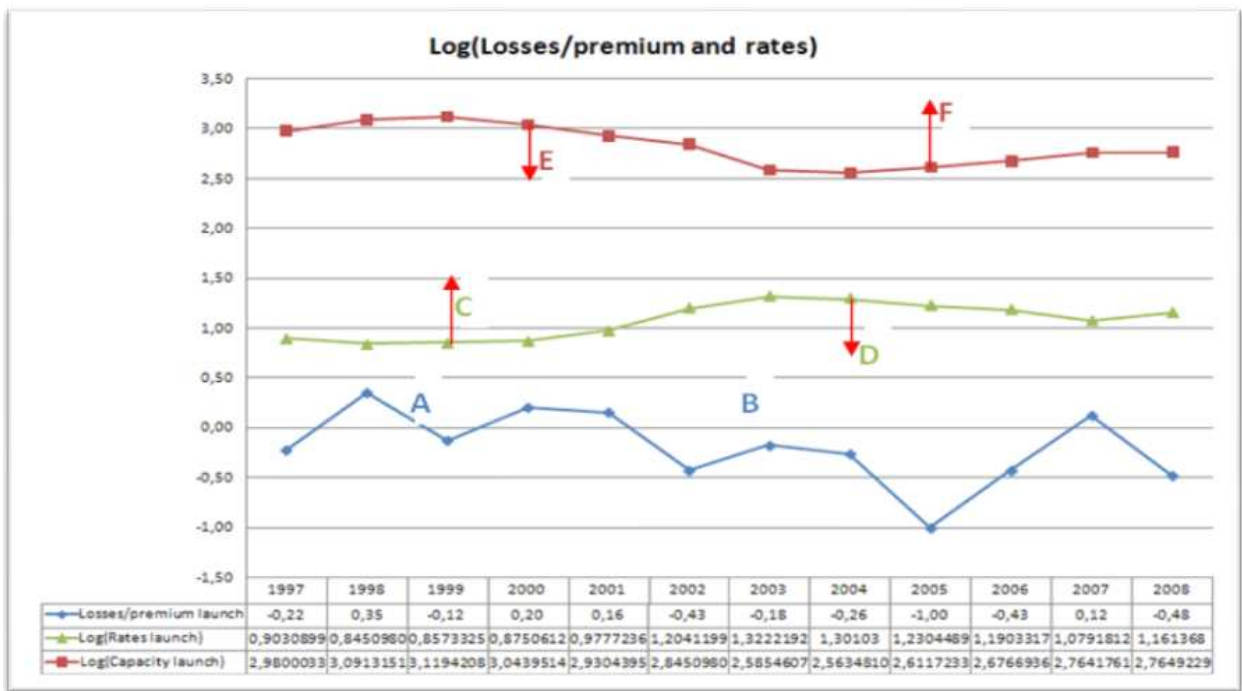


Figure 7 Logarithmic values of losses to premium rate, insurance rates and capacities for launch insurance. Data source: ISB 2008, Medvedchikov, D. 2008

The reaction of launch market is almost the same as for in-orbit market segment. Reaction on negative year 1998 (A) was increased rates (C) and decreased capacity (E). However, as can be seen on the figure above, the reaction on positive year 2002 (B) is not that fast as on the in-orbit segment of the market. This anomaly can be explained by interconnection of market segments. Launch insurance market, which used to be more profitable, was highly influenced by in-orbit market. In the Figure 8, the parallel sloping of the in-orbit and launch insurance market parameters can be seen. To prove the relationship of two market segments another iteration of correlation analysis was done. The data for analysis was taken from Table 3.

The results are illustrated in the following table:

	Rates in-orbit	Capacity in-orbit	Rates launch	Capacity launch
Rates in-orbit	1,00	-0,88	0,86	-0,79
Capacity in-orbit	-0,88	1,00	-0,86	0,89
Rates launch	-0,86	-0,86	1,00	-0,92
Capacity launch	-0,79	0,89	-0,92	1,00

Table 7 Results of correlation analysis. Data source: ISB 2008, Medvedchikov, D. 2008

As can be seen in the table above, all the insurance parameters are highly correlated. For detailed analysis, the relationship between in-orbit and launch market segments was taken (data market as green in the Table 7). According to the result of test, the relationship between the parameters is strong and positive. In order to give more precise meaning to these numbers, the coefficient of determination⁶ was calculated (Table 8).

⁶ Coefficient of determination is the proportion of the total variation in one variable that is explained by the other variable. Determination coefficient is computed by squaring the correlation. (Mason, Lind and Marchal 1994)

	Rates launch	Capacity launch
Rates in-orbit	0,74	-
Capacity in-orbit	-	0,78

Table 8 Coefficient of determination. Data source: ISB 2008, Medvedchikov, D. 2008

The results of the analysis are:

The variation in rates for in-orbit insurance explains (accounts) for 0.74 (74%) of the variation in rates for launch insurance;

The variation in capacity for in-orbit insurance market explains (accounts) for 0.78 (78%) of the variation in capacity for launch insurance market.

So in conclusion, the in-orbit market has a strong influence on the launch insurance market.

(Smirnov, I. 2005, Timofeeva, 2009, Mason, Lind and Marchal 1994)

2.2c Sun activity influence

In the same time, one of the biggest causes of the losses of in-orbit spacecrafts gives the sun activity (Smirnov, I. 2005).



Figure 8 In-orbit and launch insurance market parameters. Data source: Medvedchikov, D. 2008

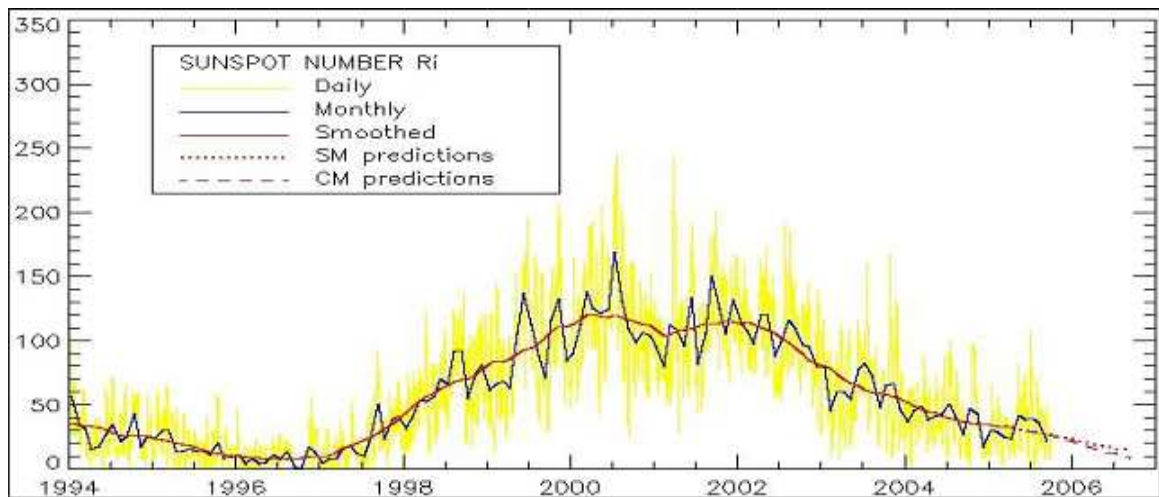


Figure 9 Sun activity cycle (Smirnov, I. 2005)

Using figures Figure 8Figure 9 we can compare sun activity and insurance market parameters, using the extreme values (solar maximum in 2001 and solar minimum 2007).

2001 solar maximum: around this year, as can be seen on the graph 7, insurance market suffered the biggest expansion of rates and decrease of capacity (sloping represented by orange lines). These market parameters were influenced by increased sequence of losses of in-orbit spacecrafts, as well as \$817M of losses during period of time from 1999-2001 connected with serial loss of satellites, based on Boeing 702 bus.

2007 solar minimum: this year was in the middle of betterment of market conditions and stabilization of parameters.

So the relationship between sun activity cycle and market conditions is strong negative (Increased sun activity worsen the market conditions)

(Timofeeva, 2009, Smirnov, I. 2005)

Conclusions

The space insurance market is yet so small, but important and even necessary for sustainable commercial space activities. The market is very dynamic and sensitive to a lot of key parameters, which drives the changes in its (market) conditions. Insurers operate with more precise data than available for space industry, which enables them to build more precise market predictions. Insurance cost is dependant on market condition, and taking in account the long duration of the space projects and big insurance costs, there is a need for more precise insurance market prediction for industry project managers, which will allow them more precise budget allocation on the first phases of project. During these report, part of the key drivers of the market were determined and studied, using quantitative and qualitative analyses.

The key finding, are that the market is always have a common trend (due the involvement of big amount of insurance companies, in the insurance of each space risk). The trends are affected by profitability level (losses to premium rate), which is the main factor of the market performance and have the biggest influence on the insurance market, but to conduct more precise mathematical analysis of that influence, more precise data need to be available. One of the most important findings, which were studied, is the relationship between in-orbit and launch market. The mathematical tests showed the strong positive correlation between these two markets. Another important issue is space weather (sun activity), because it increases the number of failures of in-orbit spacecrafts, which negatively influence the space insurance market. So there is need for precise prediction of the space weather, in-order to prevent the significant losses for space insurers.

For building a precise prediction of the space insurance market it is relevant to analyze the present market conditions, the historical trend and performance of the market in the past years, as well as prediction of space weather and reliability study of space systems.

Nowadays, the space insurance market has about \$1.5B of accumulated net result (Gross Margin), as illustrated on Figure 10. The trend in the next few years will be further accumulation of profit, if the situation with losses will remain stable. The red arrows on the figure below represent the most probable scenarios of market development, based on the year 2008 betterment of conditions (See page 9).

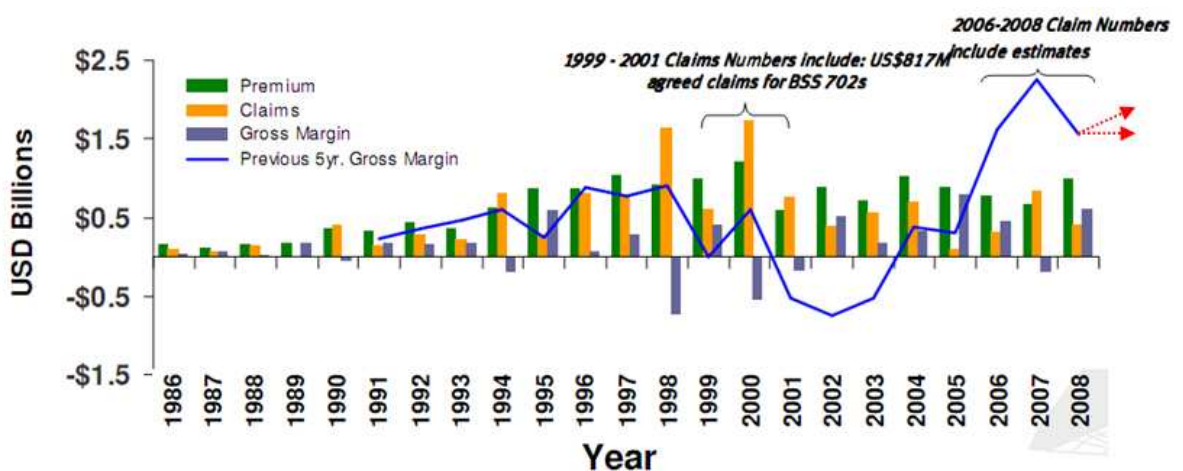


Figure 10 Premium and Claims History (De Dinechin, G. 2009)

According to the present trend, the market in 2009 will remain its conditions or will become softer. The market capacity will be still growing because insurers are attracted by good conditions and attractive risks. But the market is still too weak to withstand the significant losses, in case of which, the hardening of conditions will be experienced.

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Appendix

The author of this report would like to thank industry experts for their support and guidance:

Fuzik Taras, Malakut Insurance Broker, Deputy Director

Timofeeva Elena, Malakut Insurance Broker, Development Director

De Dinechin Guillaume, ISB, Executive Vice President

Vincent Elie, ISB France, Account Manager

Interviews data:

1) *Space Insurance Market* (29 December 2008)

Kind: personal conversation

Interviewee: Fuzik Taras, Malakut Insurance Broker, Deputy Director

Interviewer: Timofeev Aleksandr, International Space University, Student

Interview Started: 16.00

Interview Finished: 18.00

Questions discussed:

- Space Insurance fundamentals
- Space Insurance market
- Present trends
- Dynamics of the market

2) *Insurance market and Market Drivers* (03 January 2009)

Kind: personal conversation

Interviewee: Timofeeva Elena, Malakut Insurance Broker, Development Director

Interviewer: Timofeev Aleksandr, International Space University, Student

Interview Started: 09.00

Interview Finished: 11.00

Questions discussed:

- Space Insurance Market
- Key drivers
- Sources of information

3) *Analysis and interpretation of data* (15 February 2009)

Kind: telephone conversation (Sponsored by Malakut Insurance Broker)

Interviewee: Timofeeva Elena, Malakut Insurance Broker, Development Director

Interviewer: Timofeev Aleksandr, International Space University, Student

Interview Started: 18.00

Interview Finished: 18.50

Questions discussed:

- Possible techniques for data analysis
- Interpretation of test results