

Testing the Value Function of the Prospect Theory on Russian M&A Market

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Abstract: The article is devoted to the empirical implementation of the prospect theory. The subject is a value function graph. The graph itself was never been plotted on a real empirical data. In this paper a real market situation is considered. Logical indicators which describe and measure the market's actor's status and their intensives in different behavioral strategies are proposed. The empirical data from real M&A markets in Russia is collected and a real value function graph is drawn. It is compared to a theoretical value function graph which accompanies the prospect theory. A totally different shape of the curve is noticed. New shape resembles very much the graph of indifference curves, which are well known to the economists back to the late 19th century.

Keywords: Value function, Prospect Theory, Mergers and acquisitions, Behavioral discounting rate, Behavioral Finance, Discounted cash flow.

1. INTRODUCTION

Behavioral finance became very popular nowadays among traders, CFO, professors and students all over the world. Behavioral Finance is taught in many universities. Its heritage is studied by not only researchers but practitioners as well.

One of the behavioral finance's key elements is a prospect theory developed by Kahneman and Tversky. Its core graphic interpretation is a graph of hypothetical value function. It goes back to fifties of the twentieth century, when it was developed by Harry Markowitz. It is not a coincidence that in their work Kahneman and Tversky call this graph hypothetical value function (Tversky and Kahneman 1974). In fact it was never drawn on actual data in any field. While all the traders used to technical analysis and CFO's are very inspired to use it in real market situation.

In many researches devoted to Behavioral Finance there are a lot of functions describing different behavioral cases in many fields. But there is nothing similar to the core element of the key behavioral finance's theory to be developed on real data for real financial or market situation.

This is not a piece of cake. There are many obstacles which prevent achieving this goal. First of all in Markowitz paper there is a theory about the graph (Markowitz 1952). There is no hint on how to collect real data to draw it.

In Kahneman and Tversky key paper the graph illustrates their theory and is even called hypothetical value function. So even the authors of Prospect theory – the fundamental theory of behavioral finance thought of it as only theoretical, whereas practitioners admire its elegance and utility for explaining real life situations and seeking to fulfill it with real data and make it a useful instrument in their day to day satiations.

Among general modern directions of behavioral research Baker, H. Kent and John R. Nofsinger do not mention the research on establishing the shape of value function curve of prospect theory (Baker and Nofsinger 2010).

So in this paper an attempt to break through this barrier was made. The empirical value function was drawn on real data collected from real markets.

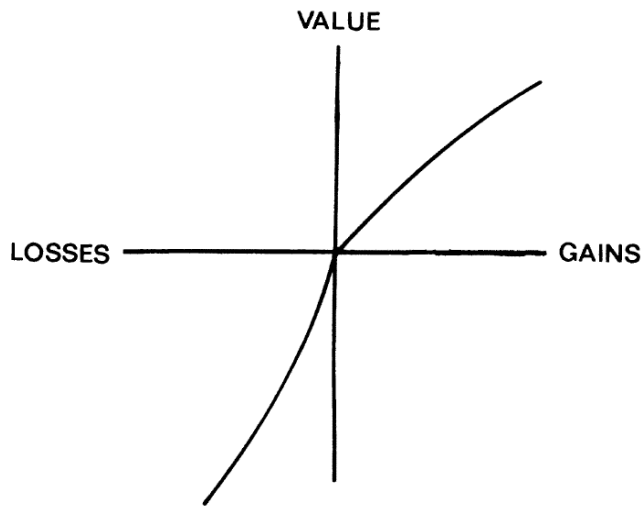
2. MEASUREMENT INSTRUMENTS

While there are two axis of the theoretical diagram of the prospect theory each of them must have its measure. On the axis of abscissa losses and gains are measured. On the axis of ordinates – the value. As indicated on the diagram from the Kahneman and Tversky main article about the prospect theory (Tversky and Kahneman 1974), as shown below.

The thing is, that there is now precise explanation what is it and how it is measured. So that is why it's called hypothetical.

This graph was in development of the ideas of different scientists who studied this problem. First there were Von Neumann and Morgenstern (1944). They

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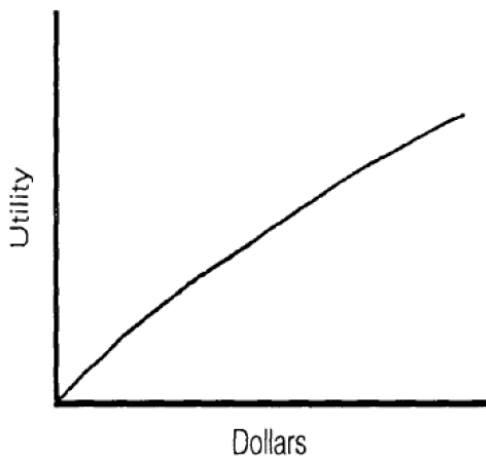


Picture 1: Hypothetical value function.

Source: Prospect Theory: An Analysis of Decision under Risk.

Daniel Kahneman; Amos Tversky *Econometrica*, Vol. 47, No. 2. (Mar., 1979), pp. 263-292.

developed expected utility theory on the foundation of Bernoulli's utility theory. A theory consistent with uniform attitude toward risk. Their results are presented on the Picture 2.

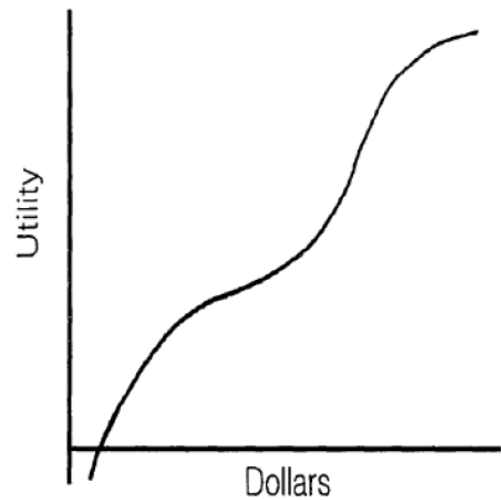


Picture 2: Utility theory's graph based on the foundation of Bernoulli's utility theory.

Source: Hersh Shefrin and Meir Statman Behavioral Portfolio Theory. *The Journal of Financial and Quantitative Analysis*, Vol. 35, No. 2 (Tun., 2000), p. 129.

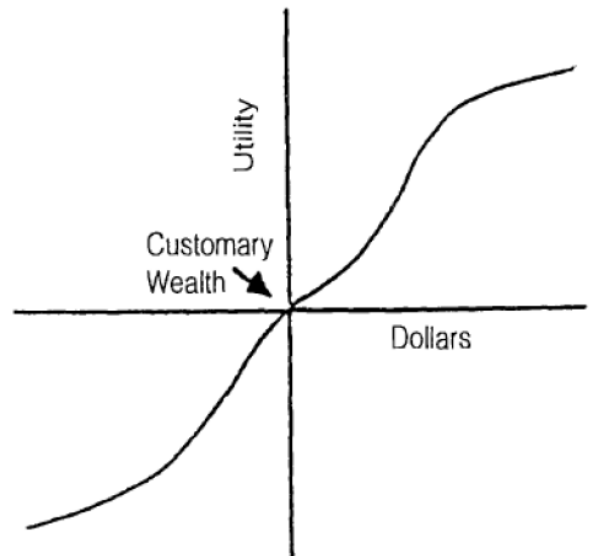
Then Friedman and Savage offered a solution to the insurance lottery puzzle based on a utility function that features both concave and convex portions, as shown on the Picture 3.

Markowitz modified Friedman and Savage's function by locating one of the inflection points. In a result the graph was changed as on Picture 4.



Picture 3: Utility theory's graph of.

Source: Hersh Shefrin and Meir Statman Behavioral Portfolio Theory. *The Journal of Financial and Quantitative Analysis*, Vol. 35, No. 2 (Tun., 2000), p. 129.



Picture 4: Utility theory's graph of Markowitz.

Source: Hersh Shefrin and Meir Statman Behavioral Portfolio Theory. *The Journal of Financial and Quantitative Analysis*, Vol. 35, No. 2 (Tun., 2000), p. 129.

The concave portions are consistent with the purchase of insurance policies and the convex portion is consistent with the purchase of lottery tickets.

To make the real graph practical and empirical, to find a measurement of the gains and losses first the Statman's behavioral model was evoked.

In his papers Statman proposes the method to assess behavioral impact with an additional coefficient to famous CAPM model (Statman *et al.* 2000). As it's known the capital asset pricing model (CAPM) is used

to describe the relationship between systematic risk and expected return for assets. CAPM is widely used throughout finance for the pricing, to generate expected returns for assets given the risk of those assets and to calculate costs of capital. Given the reality and a different approach of different participants of the investment market, mergers and acquisitions deals the CAPM model does not reflect the reality of the pricing levels of decisions made by these participants. So the additional component to CAPM formula is proposed. The whole new formula is called behavioral asset pricing model – BAPM. So in the reality of the market it is designed to reflect the real mood of the investors in the particular industry more correctly.

In recent papers the mechanism of developing the discounting rate components was described by Hubert de La Bruslerie in the paper “Decreasing term structure of psychological discount rates: Experimental estimation and determinants” (Hubert 2015). Research of implication of behavioral factors on a discounting rate was done in Russia after the crises of 2008 year (Bogatyrev 2013).

To fulfill the research with empirical data the Russian mergers and acquisitions market was observed deep into the retrospective. The first deals are dated as long as the beginning of the 21-th century. The years of whole spectrum of business and economic cycles in Russia were covered by the analyses. The analysis covered the main industries that were popular in M&A deals for all these years.

Firstly, the sell proposals of enterprises from advertisements and offers available for public use were considered on M&A market.

Then all the offers were carefully checked, additional information for accurate valuation was requested from the seller’s representatives.

The sources for the data were the open internet sites promoting the M&A deals, real data conducted transactions. The most active segment was the deals with small and medium sized businesses.

Every company was evaluated using the discounted cash flow method. After determining the value by the income approach – discounted cash flow the result was compared to the price asked by the seller.

The difference between the asked price and the value calculated is explained by behavioral factor as it is postulated in Meir Statman, Kenneth L. Fisher, and

Deniz Anginer article “Affect in a Behavioral Asset-Pricing Model” (Statman *et al.* 2000). This deference was transferred to the behavioral premium in the discount rate.

This difference was calculated by changing the discounting rate obtained with CAPM used for discounting the cash flow so that the value equals the asked price. This difference is positive and augments the discounting rate determined by behavioral asset pricing model when the seller is under confident, the market suffers from capital outflows in a crisis economy, in a shrinking industry.

This difference is negative and the seller overvalues their business when he or she is over confident, the market is growing, there may be even euphoria or a bubble, industry expands pumped with a speculative capital.

Then logic to use this instrument when measuring gains or losses on the value function of prospect theory (Tversky and Kahneman 1974) is as follows. Bubble markets and surplus of a speculative capital on the M&A market overvalue the selling enterprise (Stein 1989). So the more is the negative behavioral component in the BAPM discounting rate (the additional component of the extended CAPM formula containing behavioral factor) – the more is the seller’s gain on the future deals, as it seems to him now.

In this case under the Prospective Theory the seller faces unexpected gains.

So to use the negative amendment to the discounting rate formula which measures the unexpected surplus and seller’s gains we take it with the opposite sign in the diagram.

On the contrary, when the industry is squeezing, the capitals are fleeing the market the seller dumps the business at a bargain price. The behavioral component of a discount rate is strongly positive, so we take it with a negative side as long as this type of behavior under the Prospective Theory refers to the bottom side of the value function. The seller is under the pressing to lose all they have, so they are eager to sell it all at once without waiting the worse. Only so they minimize the negative impressions of losses of their damages.

Here is a result of calculations of the behavioral surplus to the discount rate for the retail companies operating in Russia.

So with some amendments the way to measure the gains and losses is found and approved by certain logic in compliance with Prospect Theory. It seems like a some sort of artificial mechanism but it is in accordance with the latest behavioral theories and computing techniques.

So with this technique we are provided with a approved and robust measure for the values of the axis of abscissa.

As for the axis of ordinates straight following the concept of the Prospect Theory gives us the straight answer which indicator to use. It is the value itself. Value lost or a value gained. But when applying the whole difference between the price asked and the value estimated there is a disproportion of values of different businesses appraised and different industries.

So to compile the values of the different enterprises in different industries a specific indicator was proposed. Which is calculated so that the total difference between the price and the fair market value is divided by the behavioral component of the discount rate. As for its sign, it remains the same, as it was calculated beforehand. So if the sell offer is in the growing market and the seller's price exceeds the fair market value calculated by DCF method, we put it on the chart with the same sign, simultaneously changing the sign of the percentage gain meter derived from the behavioral component of the discounting rate formula and vice versa.

3. CALCULATION OF EMPIRICAL VALUE FUNCTION COMPONENTS

For the calculation of components used for drawing the value function diagram we used real data from different years. To catch the whole spectrum of market mood from negative and panic investor feelings to euphoria and overconfidence of businessmen several periods were identified.

Firstly, the euphoria years. At the first glance it seems strange, but on Russian M&A market years from 2011 to 2012 were very promising for the deals to buy business and for expanding activity, whereas the crisis of 2008 year was just happened. It may seem as a phenomenon, but it is true, that in spite of the recent crisis the M&A market were active and growing. By all means it was not so fast growing and expanding as in nineties and in the beginning of 21 century in Russia when it was a boost in every industry. But to make the data describing the greed used for the upper right side

of the value function diagram more comparable with the data of downturn years of 2014 – 2016 we choose them.

To take into account all behavioral aspects of market participants the information about the prices of selling business from different information recourses was considered. They are all popular in Russia.

One of them is “Business for sell”. Its web site; <http://businessesforsale.ru/>

Others are:

“Shop for business sells”: <http://deloshop.ru/>

“Investing in business”: http://www.skaniainvest.ru/item/mebel_mag/

Brokerage Company on finding the counterpart on a deal of buying a business:

<http://www.bizmast.ru/prodazha-biznesa/>

Purchase and sale of working business and commercial real estate:

<http://www.bizzona.ru/searchsell/city/77>

Company of the business selling: <http://www.bizlider.ru/>

Broking Company on real estate and M&A market: <http://www.apex-realty.ru/busines-sale.html>

This diversity of information makes sure we take into account when calculating the indexes all the moods of all sellers and buyers in the market.

During the information collection from all these recourses it was possible to request and receive additional information for a business valuation from all of the above mentioned information desks.

On the first stage we have chosen the companies that were selling from these recourses. Then they were grouped along the industries. Then we collected all information needed to apply discounting cash flow method of income approach valuation. To make a research more objective valuation of all the companies was done by different valuers of different background, different experience and practice.

The results of calculations of the components needed for drawing a value function chart are presented in Appendix to the article.

The algorithm of calculations is the following.

After receiving from the broker information needed to value a business under sell the valuer implies a discount cash flow method of the income approach.

The discount rate is calculated under the extended CAPM Sharp – Lingue formula provided the current market information available at the moment of valuation.

After the market value of a business is calculated by DCF method [9] it is compared with the price asked by the business seller. If the seller’s price exceeds the market value obtained then a situation is described as positive and optimistic. The M&A market is in a positive mood, in a growth, investment capitals are competing with each other. The seller is obsessed with greed. This row of the calculation results is green marked.

Provided with the deviation between the seller’s price and market value we calculate the discount rate with which we get the seller’s price in the valuation process provided with the same baseline conditions as we used for the DCF method. Then a difference in two discounting rates is calculated which is a behavioral component of the discount rate. It is provided in a column “Behavioral adjustment to discounting rate”.

Because the businesses of different scales were analyzed to make the results comparable a weighted deviation is calculated. It is a deviation of sale price from market value divided by behavioral adjustment to discounting rate.

As long as in euphoria of a growing market the seller asks more than the market value of the business is, the behavioral adjustment to discount rate is a negative, because the seller’s price is more than the market value. Thus to use this result in a value function diagram in a positive or green segment (on the upper right segment of the diagram) we have to change its sign to the opposite. So we make it positive. The same is done with a weighted deviation.

The same procedures are done with the results of a red segment. The difference is in applying the signs of a behavioral adjustment to discount rate and with a weighted deviation. Their signs are changed from positive to negative. Because a seller is in a red zone - left bottom segment of the prospective theory value function diagram he or she is obsessed with a fear to loose all their belongings so they lower a price below the market value. A price is lower than a market value.

Behavioral adjustment to discount rate is positive so is a weighted deviation.

Behavioral adjustment to discount rate and a weighted deviation with the changed signs are put into the columns “Abscissa value” and “Ordinate value” respectively.

For drawing a upper right part of the value function diagram we collect all the data marked green. It describes so called “greed part” of the seller’s behavior and refers to a conquers curse in the behavioral finance, where the pursuit of the active sold blinds the buyer off its real value.

So we have the following Table 1.

Table 1: Indicators for Drawing the Top Part of the Value Function of Prospect Theory

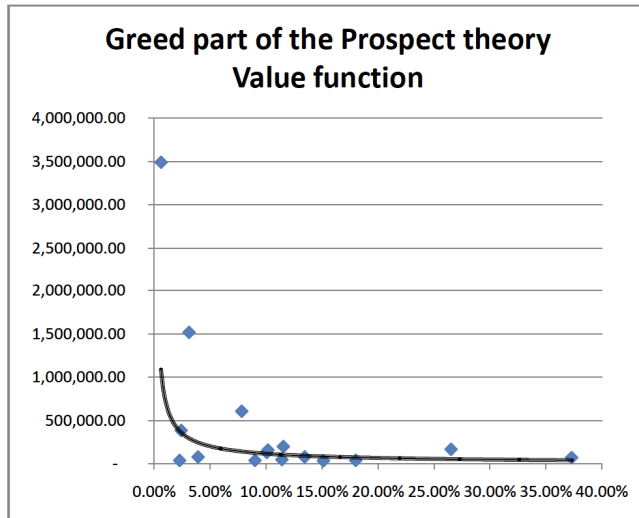
Axis of abscissa	Axis of ordinates
2,40%	384 195,69
3,10%	1 516 163,15
0,60%	3 491 197,85
15,11%	33 903,74
13,44%	78 182,03
11,40%	46 904,56
37,30%	70 390,53
10,05%	129 970,71
26,52%	166 146,52
2,26%	38 134,81
11,53%	198 031,12
3,91%	77 714,80
18,00%	38 717,32
9,00%	38 095,54
10,15%	157 830,12
7,81%	605 433,42

Source: Author’s research.

With these data we have the following diagram with polynomial approximating function:

Accuracy value of approximation (R^2) – is 0,867.

For drawing the bottom part of a value function diagram we collect red raws of the calculations, they are presented in the Table 2.



Picture 5: Upper part of value function diagram.
Source: Author's research.

Table 2: Indicators for Drawing the Bottom Part of the Value Function of Prospect Theory

Axis of abscissa	Axis of ordinates
-23%	- 2 904 721,03
-97%	- 109 529,37
-141%	- 131 171,10
-25%	- 665 630,93
-78%	- 58 714,32
-77%	- 30 963,34
-127%	- 64 315,75
-32%	- 85 593,79
-23%	- 161 792,97
-56%	- 31 969,85
-80%	- 29 466,14
-87%	- 5 483,27
-80%	- 15 914,86
-26%	- 1 313 894,25
-25%	- 149 620,24
-28%	- 729 625,39
-70%	- 69 731,04
-18%	- 75 204,07
-13%	- 52 607,89

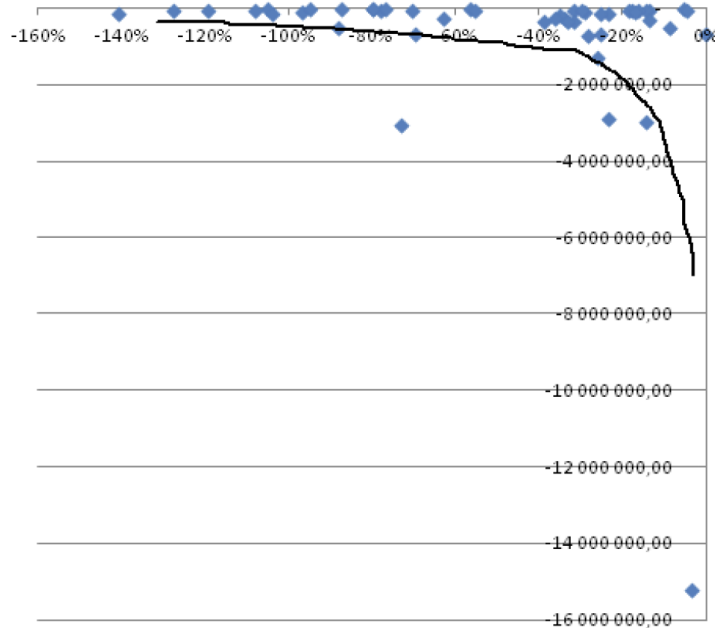
(Table 2). Continued.

Axis of abscissa	Axis of ordinates
-14%	- 46 107,36
-5%	- 31 626,04
-5%	- 59 067,37
-108%	- 82 485,72
-34%	- 261 523,56
-105%	- 5 338,86
-16%	- 48 242,27
-119%	- 65 780,20
-35%	- 182 672,26
-56%	- 83 069,53
-104%	- 145 444,33
-63%	- 280 412,70
-73%	- 3 073 836,02
-18%	- 67 930,73
-29%	- 117 236,24
0%	- 659 344,09
-3%	- 15 228 873,52
-70%	- 695 258,26
-88%	- 512 068,85
-95%	- 37 217,45
-30%	- 56 873,06
-39%	- 342 237,64
-17%	- 102 511,27
-14%	- 326 823,56
-9%	- 516 852,22
-14%	- 2 985 633,05
-36%	- 286 598,91
-32%	- 366 696,12
-33%	- 358 205,15

Source: Author's research.

With these data we have the following diagram for the "fear of losses" part of the value function diagram with polynomial approximating function:

Fear part of the Value function diagram

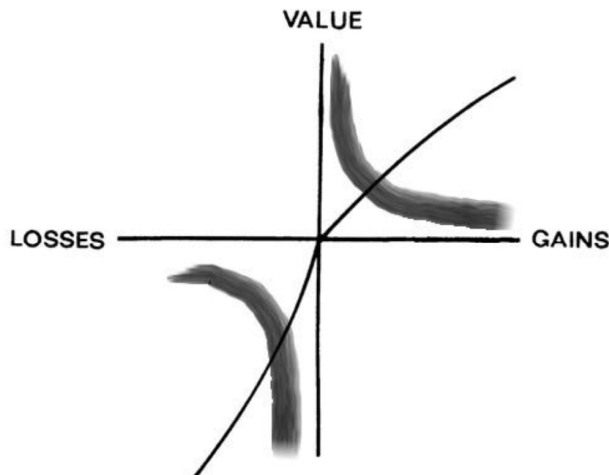


Picture 6: Bottom part of value function diagram.

Source: Author’s research.

Accuracy value of approximation (R^2) – is 0,11.

So if we combine these two parts together and smooth the approximating trend lines we will have the following schematic diagram which we combine with the original value function graph:



Picture 7: Empirical versus Hypothetical value function.

Source: Author’s analysis.

Thin lines mark the Hypothetical value function, as described in a prospect theory, thick lines mark the graph drawn on real empirical data collected in accordance with a paper’s study.

So as we can see the real value function graph resembles very much the classical indifference curves, proposed long time ago by economist Francis Ysidro Edgeworth in 1881 (Spiegel 1991). Such an unexpected turn in behavioral research returns us to a long-known research techniques that can provide behavioral researchers with new benefits.

4. CONCLUSION

The prospect theory is a key element of the behavioral finance.

The core element of a prospect theory is a value function graph which has a significance and its meaning according to the prospect theory, so that it’s shape is meaningful for the theory.

The graph itself was never been drawn on a real empirical data.

In this paper we have chosen a real market situation which illustrates a behavioral aspects of its participants in two opposite stages: an euphoria of growth and a panic of a disastrous decline.

We proposed logical indicators which describe and measure the market’s actor’s status and their intensives in these two different conditions.

Appendix: Example of the calculation of the value function components

Year	Industry	Company description	Discounting Rate by CAPM	Discounting Rate by BAPM	Behavioral adjustment to discounting rate: (5)-(4)	Seller's price, RUR	Market value by DCF, RUR	Deviation of sale price from market value: (7) – (8), RUR	Diagram's segment	Weighted deviation (Deviation of sale price from market value divided by Behavioral adjustment to discounting rate): (9)/(6)	Abscissa value: -1* (6)	Ordinate value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
2012	Furniture manufacturing	Furniture manufacturing plant in Moscow region	19,60%	42,90%	23,30%	99 000 000,00	166 680 000,00	- 67 680 000,00	red	- 2 904 721,03	-23,30%	- 2 904 721,03
2016	Garment industry	Sewing shop for sewing household textiles and curtains.	20,00%	116,88%	97%	2 200 000,00	12 811 205,03	- 10 611 205,03	red	- 109 529,37	-97%	- 109 529,37
2014	Education services	Chain of educational offices, Pushkino	27,53%	25,27%	-2%	2 100 000,00	2 013 891,61	86108,3942	green	-38134,80	2 %	38 134,81
2016	Furniture manufacturing	Furniture production. Kazan. Tatarstan. 2 exhibition halls, production capacities.	30,00%	48,40%	18%	3 200 000,00	4 449 925	-1249925,465	red	-67930,73	-18%	-67930,73181
2016	HORECA	Café. «Coffee like» - cafe of a new format. Mytyschi.	23,00%	5,00%	-18%	1 400 000,00	703 088,28	696911,7199	green	-38717,31	18%	38717,31777
2016	Transport services	Taxi service. Balaschiha.	25,00%	9,00%	-16%	9000000	11790756,54	-2790756,543	red	174422,28	16%	174422,2839
2016	Transport services	Rental business.	25,00%	4,00%	-21%	13000000	14738445,68	-1738445,678	red	82783,12	21%	82783,12753
2016	Transport services	Car rental company.	25,00%	2,00%	-23%	15000000	17686134,81	-2686134,814	red	116788,47	23%	116788,4702
2016	Wholesale	Company for the sale of car wash equipment with a net profit of 250 thousand rubles per month.	23,73%	60,04%	36%	6 800 000,00	17206406,44	-10406406,44	red	-286598,91	-36%	-286598,9105
2016	Household Services	Car service. Age 10 years. Moscow.	23,73%	56,75%	33%	8 500 000,00	20327934,1	-11827934,1	red	-358205,15	-33%	-358205,1514

Source: Author's research.

We collected the empirical data from real M&A markets in Russia and draw a real value function graph. When we compared it to a theoretical value function graph which accompany the prospect theory we noticed, that it has a totally different shape. But the surprise is that it resembles very much the graph of indifference curves, which are well known to the economists back to the late 19th century.

This amazing finding gives a new life to the old research techniques, proves the need to confirm theories with real data and shows that the practical content of the theory may differ from the hypothetical.

This paper does not mark the end of the research of the value function and does not state the final proof of its shape. It just provides with a small result on a certain market in certain conditions and gives a technique to use on other markets in different time horizons to test useful and effective prospect theory's tool: value function.

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