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Beer Annuities: *Hold the Interest and Principal*

CARLOS E. ORTIZ, CHARLES A. STONE, AND ANNE ZISSU

CARLOS E. ORTIZ is a professor and chair of the Department of Mathematics and Computer Science at Arcadia University in Glenside, PA.
ortizc@arcadia.edu

CHARLES A. STONE is a professor in the Murray Koppelman School of Business at Brooklyn College, City University of New York in Brooklyn, NY.
cstone@brooklyn.cuny.edu

ANNE ZISSU is a professor in the Department of Business at Citytech, City University of New York in Brooklyn, NY and in the Department of Finance and Risk Engineering at the New York University Tandon School of Engineering in New York, NY.
zissu@sprynet.com

In 2016, the Belgian brewery De Halve Maan (DHM) completed the construction of a pipeline that now transports beer from its brewery in Bruges to its bottling plant located in a modern industrial park 3.2 kilometers away. DHM incorporated a unique form of crowdfunding into the €4.5 million needed to build the pipeline. DHM raised capital by offering investors a flow of beer for life. The value of these beer annuities, like life insurance contracts, annuities, and life settlement contracts, depends on the beneficiary's life expectancy. In this article, the authors model the value of the beer annuities as a function of the expected beer inflation rate, the life expectancy of the investors, and the discount rate. They show that the design of the beer annuities offered by DHM present arbitrage opportunities to the people who subscribe to the beer annuities and the general population of beer drinkers. This is important for project sponsors who intend to incorporate reward annuities into their crowdfunding plans.

We discuss the value derived by the crowdfunding of part of the construction costs of a beer pipeline that now connects the De Halve Maan (DHM) brewery in the historic center of Bruges, Belgium, to the company's bottling plant 2.3 kilometers outside of Bruges.

The premise of crowdfunding is to tap into a group of people who have a desire

to make small investments that will nudge a project to success. Something about the project must excite people in the crowd sufficiently so that they are willing to participate. For the DHM pipeline financing, the crowd wanted to be part of an innovative solution to a problem that had both business and civic dimensions. Transporting beer by an underground pipeline was the solution. The reward was a supply from the end of the pipeline: bottles of Brugse Zot. Brugse Zot is currently the only beer brewed in the historical center of Bruges. Prior to World War II, there were more than 30 working breweries in Bruges.

The engineering problems to be solved in the construction of the pipeline were to use a very strong food-grade material for the pipeline, to build it underground without disrupting or destroying ancient structures, and to find the space to lay out and connect long stretches of the pipe before placing it in the ground. Part of the pipe had to be floated in the canals of Bruges and then hoisted and placed in the trenches. The financing of the pipeline, which is the focus of this article, attracted the interest of the media because it was a unique project in a unique place and it employed crowdfunding. The pipeline was financed with capital supplied by the brewery (80%), the public sector (10%), and the crowd (10%). The focus of our discussion is the terms of the crowdfunding portion of the financing.

The production growth of DHM was becoming constrained by the medieval design of the city of Bruges. The physical location of the DHM brewery in the UNESCO-designated Heritage Site—characterized by narrow, nonlinear streets woven through a city that was built around canals and is now congested with modern traffic and a brisk tourist trade—is not a design that is conducive to transporting an increasing flow of beer by tanker trucks. The CEO of De Halve Maan faced the choice of moving the brewery out of the center, moving the beer more efficiently from the brewery to the bottling plant, or doing nothing and sacrificing future growth.

The DHM beer pipeline was approved by the local government in September 2014, and by September 16, 2016, the beer began to flow from the DHM brewery to its bottling plant. The pipeline can transport beer at a rate of 4,000 liters/hour. The crowdfunding portion of the beer pipeline arranged by DHM closed to funders on December 31, 2015. The construction period was four months.

DHM made the following offers to individuals:

Gold Membership

An individual contributing €7,500 to the construction of the pipeline will receive one 33 cl bottle of Brugse Zot Blond (BZB) daily for the rest of his/her life.

Silver Membership

An individual contributing €800 to the construction of the pipeline will receive one case of 24 33 cl bottles of Brugse Zot Blond (BZB) yearly for the rest of his/her life.

Bronze Membership

An individual contributing €220 to the construction of the pipeline will receive one 75 cl bottle of Brugse Zot Blond (BZB) yearly for the rest of his/her life.

Our analysis focuses on the longevity risk embedded in the beer annuity offered by DHM to raise funds for a beer pipeline. Like all annuities, the value/cost to the annuitants/issuer depends on how long they expect to receive/make payments.

MODEL

The value of this structured financing is determined by the life expectancy n^* of the *beerees* (the investors in the gold, silver, and bronze memberships), as shown in Equation (1):

$$V = \sum_{t=1}^n b \left(\frac{1+\pi}{1+r} \right)^t, \quad (1)$$

where V is the present value of the bottles of beer b received periodically by the *beerees* for the remainder of their lives n .

We label V^* the amount of capital raised by the *brewer* (DHM), from the gold memberships, in our example €7,500 per subscription. We must find the n^* that corresponds to V^* . If the *beerees* live longer than n^* , the *brewer* will have to provide beer over a longer period, above n^* . In such a case, the value of the beer flowing from the brewer to the crowd will be greater than the value collected in the sale of the memberships. We summarize this loss by writing $V < V^*$. If the *beeree* lives less than n^* , then the *brewer* will have to supply fewer bottles of beer over a shorter period, creating a value for the *brewer*. This is the case when $V > V^*$. The interest rate and inflation rate are represented by r and π , respectively.

The actual life n of the *beeree* is the key component to the success or failure of this funding program for the *brewer* in terms of economic value. We are not considering marketing value that may be derived from this crowdfunding program.

Solving for the Variable n

In this section, we solve Equation (1) for the variable n .

Let $x = \left(\frac{1+\pi}{1+r} \right)$. We will use the following well-known power series identity.

$$V = \sum_{t=1}^n bx^t = bx + bx^2 + bx^3 + \dots + bx^n = \frac{b(1-x^{n+1})}{(1-x)} - b,$$

and solve for n as follows:

$$V = \frac{b(1-x^{n+1})}{(1-x)} - b$$

and

$$(V + b) * (1 - x) = b(1 - x^{n+1}).$$

This in turn gives us:

$$1 - \frac{(V + b) * (1 - x)}{b} = x^{n+1}.$$

We now apply logarithms on both sides of the previous equation:

$$(n + 1) \log(x) = \log\left(1 - \frac{(V + b) * (1 - x)}{b}\right)$$

which can be expressed as:

$$(n + 1) = \frac{\log\left(1 - \frac{(V + b) * (1 - x)}{b}\right)}{\log(x)}.$$

We then have the following expression for n :

$$n = \frac{\log\left(1 - \frac{(V + b) * (1 - x)}{b}\right)}{\log(x)} - 1.$$

For our purposes, we can rewrite the expression above as follows:

$$n = \frac{\log\left(\frac{b - (V + b) * (1 - x)}{b}\right)}{\log(x)} - \frac{\log(x)}{\log(x)},$$

which yields

$$n = \frac{\log\left(\frac{bx - V(1 - x)}{b}\right) - \log(x)}{\log(x)} \quad (2)$$

Interpretation of n

If the *beeree* lives less than n years following his initial investment, then the *brewer* ends up paying out less in beer value than the amount of capital raised. If the *beeree* lives exactly n years after his investment, he breaks even, and if he lives longer than n years after the investment, he will realize an economic gain. The value of n depends on the inflation rate and the discount rate.

SOME DATA ON BEER INFLATION, LIFE EXPECTANCIES, AND DISCOUNT RATE

The cost to DHM of offering the beer annuities can be viewed as foregone profit. The payment of beer is a reduction in revenue to the extent that sales of beer fall by the amount of the annuity payment. People who receive the beer via the annuity will likely reduce their in-store purchases of beer.

Each euro reduction of revenue will decrease profits before interest and taxes by some fraction. In the case of the Boston Beer Company (SAM), this would be approximately 15 cents (operating income divided by revenue). In the case of Duvel Moortgat, a Belgian brewer that has been actively acquiring American craft brewers, a ratio of EBITDA/revenue is reported at 30%. This means that 30 cents of every dollar of revenue foregone translates into a reduction of 30 cents of earnings before interest, taxes, depreciation, and amortization. Since DHM, the *beeror*, is not a public company, we can only estimate its opportunity cost of each bottle of beer paid to a *beeree*. We have decided to use €0.15 in our model, with the results shown in Exhibits 6, 7, and 8. Keep in mind that the production volumes of these brewers are different by magnitudes. The Boston Beer Company produces approximately 120 times more beer than DHM annually, and Duvel Moortgat produces approximately 35 times more beer than DHM. Our profit margin numbers are used to anchor our model in a reasonable guess, not as a number that is used to make judgments about the management or business models of the brewers.

When the pipeline funding was completed in 2015, the price of a bottle of Brugse Zot in the supermarket was approximately €1.24 in Brussels (in the retail chain of Carrefour.) This is the price we use as our time-zero benchmark price for the members. From 2015 to 2016, the price of beer in Belgium increased at a rate of 3.92%. Beer inflation rates were considerably higher than the general inflation rate in both the 19-country euro area and in Belgium. The difference between the inflation rate of beer and the general rate of inflation in Belgium for the years 2013, 2014, 2015, and 2016 were: 3.79%, 3.23%, 3.87%, and 2.15%, respectively (See Exhibit 1 for recent beer inflation data). The European Central Bank's target inflation rate for the euro area is just below 2%. We incorporate the inflation rate of beer in Belgium into our model, letting the rate range from

EXHIBIT 1

Recent Beer Inflation Data

Year	Inflation Rate in European Union	Inflation Rate in Belgium	Inflation Rate of Beer in Belgium
2007			
2008	3.34%	4.49%	3.39%
2009	0.32%	-0.01%	4.94%
2010	1.61%	2.33%	1.82%
2011	2.72%	3.36%	-0.23%
2012	2.50%	2.63%	2.44%
2013	1.34%	1.25%	5.04%
2014	0.43%	0.49%	3.72%
2015	0.03%	0.62%	4.49%
2016	0.24%	1.77%	3.92%

Note: The inflation rates are calculated from the year-over-year changes in the harmonized indexes of consumer prices (HICP) that are published by Eurostat (<http://ec.europa.eu/eurostat/web/hicp/data/database>).

1% to 5%. Beer annuities serve as a source of beer and as well as an inflation hedge.

It is important to emphasize that people who participate in crowdfunding look beyond the risk/reward profile of expected payoffs. There are intangible returns that motivate people to back ventures. The excitement of being a venture capitalist and knowing that you were able to help nudge a community or business in a “positive” direction may be worth more than a few basis points. Beer tastes better when it flows through a pipe you helped fund and which did a bit to preserve the character and environment of a very special city.

The capital of the West Flanders region of Belgium is Bruges. Life expectancy for a person born in West Flanders in the year 2014 was 82.1 years (as per Eurostat data). This implies that a birthday gift to a newborn baby of a gold beer annuity would commit the brewer to a beer a day for an expected 82.1 years. It is more relevant to use the mortality table data published by the World Health Organization (WHO), which gives life expectancies based on a cohort’s current age. In Exhibit 2, we present the 2015 WHO mortality data for men in Belgium, the year the pipeline funding was completed. We run our model to find out how many years a *beeree* needs to live before he will be indifferent between buying beer off the shelf and buying beer in return for financing the DHM pipeline.

The legal drinking age for beer in Belgium is 16 years.

EXHIBIT 2

2015 Mortality Data for Men in Belgium

Age in 2015	Life Expectancy in Belgium (years)
15–19	64.0
20–24	59.1
40–44	39.9
60–64	22.1
80–84	8.2
90–94	3.9

Source: World Health Organization (<http://apps.who.int/gho/data/view.main.LT61950?lang=en>).

While we do not know the age distribution of the funders, the life expectancy data clearly have implications for the value on both sides of the transaction. The data imply that an 80-year-old man who bought the beer annuity can expect a bottle of beer a day for the next 8.2 years and a man between 20 and 24 years of age can expect the beer to flow for another 59.1 years. The price of the annuity was the same for both men. Older beer drinkers subsidize younger beer drinkers. Of course, pricing the annuities according to life expectancy, while perhaps attracting younger investors, could just as likely drive away older wealthier people who invested in the project. In November 2016, Labatt Brewing Company stopped giving its retirees free beer for life. This perquisite had been part of their employee benefit package.

At the core of our model is the discounting of the stream of beer that flows to the *beeree*. The discount rate we use must incorporate some realistic measure of premiums for risk, liquidity, and inflation. We look at three reference yields to come up with a reasonable range over which to run our model. A starting point is to examine what yield investors require in order to purchase the debt of beer brewers. For example, the yield on 10-year euro-denominated medium-term notes issued by Heineken in October of 2015 was 2%. At the same time, the yield on sovereign AAA-rated euro debt was 0.73%. This spread of 127 basis points incorporates premiums for credit, liquidity, and expected inflation. Capital would not flow to DHM at a lower rate than it flows to Heineken, a multinational brewing giant with a long-term credit rating from Standard & Poor’s of BBB+ and a short-term rating of A-2. The yield on the BofA Merrill Lynch Euro High Yield Index on

October 20, 2015, was 5.12%. We think this is a reasonable range of discount rates to use in our model, the rate Heineken paid for credit, 2%, and the average rate of below-investment-grade corporate issuers of debt denominated in euros, 5.12%. We have run our model with discount rates that cover the range of 1% to 5%.

SIMULATIONS

In the next three exhibits, we use Equation (2) to find the number of years a *beeree* has to live to break even with his initial investment, across a range of interest and inflation rates from 1% to 5% each.

Exhibit 3 shows that a gold member regains his initial investment of €7,500 faster as inflation rates increase, and at lower rates of interest. With the combination of those rates, the *beeree* needs a life expectancy, n , ranging from a minimum of 12.58 years (north/east corner of Exhibit 3) to a maximum of 27.42 years (south/west corner), to realize a positive value.

It takes much longer for the silver member to realize economic value from his initial €800 investment, and actually, with an interest rate of 5% and inflation rate of 1%, the investment never yields a positive economic value.

Perhaps because the cost of becoming a bronze member is €220, far less than the cost for gold or silver memberships, younger investors, with less money but higher life expectancy, will chose bronze memberships. We observe in Exhibit 5 that the earliest a bronze member can begin to earn a return on his investment is after 30 years. We also observe in the lower south/west portion of the table (5% discount rate and 1% inflation rate) that the *beeree* will never have a positive return on the €220. In other words, buying beer on the spot market would always be a better consumption decision.

EXHIBIT 3 Gold Membership

$r \backslash \pi$	1%	2%	3%	4%	5%
1%	17.0	15.2	14.2	13.3	12.5
2%	18.1	17.0	15.2	14.2	13.3
3%	20.2	18.1	17.0	15.2	14.2
4%	23.1	20.2	18.1	17.0	15.2
5%	27.4	23.0	20.1	18.1	17.0

In Exhibits 6, 7, and 8, we show how many years it takes for the net present value of the beer annuities—gold, silver, and bronze—to become a liability to the brewer.

For example, in Exhibit 6, with an inflation rate of 3% and interest rate of 2%, the cost of supplying the beer to a gold member is lower than the initial investment of

EXHIBIT 4 Silver Membership

$r \backslash \pi$	1%	2%	3%	4%	5%
1%	27.0	23.7	21.3	19.5	18.1
2%	31.3	27.0	23.7	21.4	19.6
3%	38.6	31.3	27.0	23.7	21.4
4%	54.5	38.4	31.2	27.0	23.7
5%	Never	53.7	38.3	31.2	27.0

EXHIBIT 5 Bronze Membership

$r \backslash \pi$	1%	2%	3%	4%	5%
1%	59.0	46.3	38.9	33.9	30.3
2%	89.2	59.0	46.4	39.0	34.1
3%	Never	88.6	59.0	46.5	39.1
4%	Never	Never	88.1	59.0	46.6
5%	Never	Never	Never	87.6	59.0

EXHIBIT 6 Beeror with Gold Members

$r \backslash \pi$	1%	2%	3%	4%	5%
1%	137.0	86.4	66.1	54.6	47.0
2%	Never	137.0	86.6	66.4	54.9
3%	Never	Never	137.0	86.9	66.7
4%	Never	Never	Never	137.0	87.2
5%	Never	Never	Never	Never	137.0

EXHIBIT 7 Beeror with Silver Members

$r \backslash \pi$	1%	2%	3%	4%	5%
1%	223.0	117.3	85.1	68.4	57.8
2%	Never	223.0	117.8	85.6	68.8
3%	Never	Never	223.0	118.3	86.0
4%	Never	Never	Never	223.0	118.7
5%	Never	Never	Never	Never	223.0

EXHIBIT 8

Beeror with Bronze Members

r/π	1%	2%	3%	4%	5%
1%	489.0	178.2	119.8	92.7	76.6
2%	Never	489.0	179.2	120.6	93.3
3%	Never	Never	489.0	180.1	121.3
4%	Never	Never	Never	489.0	181.0
5%	Never	Never	Never	Never	489.0

€7,500 as long as the *beeree* lives less than 86 years after his initial investment. The sections of Exhibits 6, 7, and 8 where it says “NEVER” means that the cost of the *beeror* will never exceed the initial investment. The worst-case scenario is a 5% inflation rate and an interest rate of 1%, in which the company’s cost exceed the initial membership investment, after *only* 47 years. Assuming that a gold member is financially established at the time of the investment, due to a number of years in the work force, we can estimate his minimum age at that time to be 40. If so, he would have to live until age 87 for the company to reach its breakeven point.

In Exhibit 7, we observe that the brewer benefits more from the silver membership than from the gold membership, as it takes longer for its costs to exceed the initial investment.

In Exhibit 8, we can see that the brewer benefits even more from the bronze members. In this case, the earliest its cost of serving the beer can exceed the initial amount raised (€220) is 76 years. For most combinations of discount rates and rates of inflation, any reasonable life expectancy of the *beeree* is exceeded.

ARBITRAGE

Gold *beerees* had to invest €7,500 in exchange for 365 bottles of beer per year. The silver *beeree* had to invest €800 in exchange for 24 bottles of beer per year. We develop a short example to demonstrate a possible arbitrage between the gold *beeree* and the beer drinking community of Bruges.

The gold *beeree* would sell a portion of his investment to nine new, what we call now silver star *beerees*, for €800 each, the same price as an original silver membership, for a total of €7,200. Instead of each silver star investor receiving 24 bottles per year as did the original silver *beeree*, he/she would be paid an additional 20% per year, or 28.8 bottles per year by the gold *beeree*/

EXHIBIT 9

Gold Star Beeree

r/π	1%	2%	3%	4%	5%
1%	3.0	2.2	2.2	2.1	2.1
2%	2.3	3.0	2.2	2.2	2.1
3%	2.3	2.3	3.0	2.2	2.2
4%	2.3	2.3	2.3	3.0	2.2
5%	2.4	2.3	2.3	2.3	3.0

EXHIBIT 10

Silver Star Beeree

r/π	1%	2%	3%	4%	5%
1%	23.0	20.1	18.3	17.0	15.8
2%	25.4	23.0	20.1	18.4	17.0
3%	29.8	25.3	23.0	20.1	18.4
4%	37.3	29.7	25.3	23.0	20.1
5%	55.9	37.0	29.6	25.3	23.0

arbitrageur. The result is that the gold *beeree* pays a total of 259.2 bottles per year, and nets 105.8 bottles (29% of the original 365 bottles) per year. The gold *beeree*’s cost of this lifetime annuity is €300 (4% of €7,500). We now call him the gold star *beeree*.

The silver star *beeree* benefits both from shortening the number of years he must receive beer before the annuity has a positive value based on the initial investment of €800, and from extending the range of interest rates over which this value is realized.

The effect of the arbitrage trade for the gold star *beeree* is that he recovers his net investment of €300 under all ranges of interest rates and life expectancies, just after two years. The only risk is that the brewer cannot honor the beer annuity. We have illustrated the position of the gold star *beeree* in Exhibit 9.

Exhibit 10 shows how the silver star *beeree* recovers his initial investment several years sooner than the regular silver member. For example, the silver member (see Exhibit 4) needs to wait 27 years to break even for a 1% interest rate and 1% inflation rate, while the silver star *beeree* breaks even after 23 years.

We see that the gold star and silver star annuities, created through the arbitrage, offer a wider range of values above initial investments than the beer annuities issued directly by DHM. This implies that DHM has left “money on the bar.” Exhibits 9 and 10 illustrate

how arbitrage extends the ranges of values above initial investment that may be realized by *beerees*.

CONCLUSION

While our focus was to analyze the economic value of the beer annuities offered by DHM, a broader context of this article is to indicate that nonmonetary rewards structured as annuities may broaden the scope and depth of the private and civic crowdfunding market. Reward annuities in the form of a product or service may tie the funder to the long-term success of the venture and offer the stakeholders of the project a long-term connection to each other more than a onetime reward. The annuity reward, if designed properly, may also enable the project sponsors to raise a larger amount of funds more quickly. Crowdfunding is becoming a popular way for entrepreneurs to finance civic and private ventures.

There is a project that was funded on Kickstarter, “Bring Bicycle Boulevards to Durham” (BBD). The goal of the project is to design and build a 15-mile “bicycle priority corridor” that enables cyclists to safely navigate throughout Durham, North Carolina.

The sponsors of this project come from the business, civic, and nonprofit sectors, and they had a funding goal of \$7,500 by March 1, 2017. The project was fully funded; 160 backers pledged \$7,768.

For a pledge of \$10 to the BBD project, the backer received a coffee mug with the logo of the project. Forty-four backers went for the T-shirt at \$35 with the project logo. This type of reward for the minimal investment is typical of a crowdfunded project. Eighteen backers have pledged \$75 in return for a single bicycle tune-up from the Durham bike shop Bullseye. There is a menu of rewards for various pledges. The idea is to gauge the reward/pledge combinations such that you tap into the different tastes of the crowd.

The civic and entrepreneurial elements of crowdfunded projects give people a way of participating in meaningful community enhancing endeavors and receiving output produced or derived from the

successful completion of the project. Did management of the Bullseye bike shop or sponsors of the BBD project in Durham consider offering as a reward a free bicycle tune-up once a year for life? What should be the price of this service annuity such that it offers value to the funders, the bike shop, and the project sponsors? These are complex questions in part because the success of the BBD project will likely increase the flow of bicycle traffic in Durham, the sales of bicycles in the area, and the demand for required tune-ups.

Reward-based annuities may be an effective way of raising capital and securing a loyal customer base. Without specific demographic information about the people who are buying the reward annuities, it will be difficult to price them correctly. The longevity risk, if mispriced, could ruin the feasibility of a project or the supplier of the rewards. Funders must account for the possibility of product or service obsolescence, life expectancy, inflation, and counterparty risk. This is a difficult analysis and people will likely react to this complexity by buying goods and services on the spot market rather than with long-term supply contracts in the form of lifetime annuities.

Innis & Gunn (IG), a Scottish craft brewer, raised £3.1 million by issuing beer bonds to finance the construction of a new brewery. Ultimately the proceeds were used to buy an existing brewery. This was also a crowdfunded project. The crowd is a wide source of capital for projects that offer returns plus involvement in the battle of David versus Goliath. The Goliath may be the multinational beverage conglomerate, the cars that keep knocking us off our bicycles, the big Hollywood movie studio, or development that strips out the charm of our once great commercial centers, like Bruges. Our article shows that the structure of the rewards offered to the crowd can make this type of funding more efficient.

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