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ECONOMIC ANALYSIS OF SUBCONTRACT DISTILLERIES BY SIMULATION MODELING METHOD

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Abstract: *The economic analysis of the subcontract distilleries is a less-explored area of literature. At present, there are approx. 140 commercial and 500 subcontract distilleries in Hungary, in the distribution of production, the former is about 2 million, the latter producing 9 million liters of 50% vol distillate. In the study we carried out an economic analysis of subcontract pálinka distilleries by simulation modeling. Prior to our study, we defined which distillery can be considered to be average in Hungary today and this was taken into account in the marginal conditions of the investigations. Calculations were made using @Risk 7.5 software package. The special feature of margin calculation compared to commercial distilleries that they do not have their own fruit base. It has been proven that the cost of distillation can vary from 331 to 1068 HUF/litre taking into account the extreme values of 1000 simulations, and the average of self-cost is 545 HUF/litre. Based on the empirical distribution of the simulations, it can be stated that 61.1% probability is that the cost below 550 HUF margin level is expected, what is to say the distilling is profitable. Increasing production can significantly reduce the cost of distillation production by up to 30% compared to the original value but practically not, or very difficult to implement. When examining the elements of the cost factors, it was found that four determinants (cost elements and production) that have a decisive influence on the first cost. Income per liter is closely related to the first cost. According to the simulation results, it can vary between -239 and + 150 HUF/litre at 90% probability. The most significant increase in cost is the specific wage cost, and the effect of changes in energy and general costs is only six-tenths of the wage cost. It is advisable to continue making pálinka as a part-time job. By simulation modelling, setting a 1% tolerance for the difference between revenue and expense, we found 29 cases where the production volume can be considered as a brake even point. By determining the simple arithmetic mean of these cases, we can declare that the brake even quantity is 13892 liters. By setting the minimum and maximum values, we have developed a model applicable to any payroll, which can be used for cost-benefit calculations. Generally, the pálinka making can be considered as a profit generator, but the resources, location, and demand have a great influence on this income-generating capacity.*

Keywords: *subcontract distilling; margin calculation; simulation modeling; first cost; income.*

JEL Classification: *C15; L66; Q00.*

1. Introduction

The economic analysis of the subcontract distilleries is a less-explored area of literature. Although several authors also dealt with the competitiveness, distribution channels and profitability of palinka (Kopcsay, 2010, Török, 2010, 2011, Koris, 2015), the studies were focused mainly the commercial distilleries. The article dealing with the return on technological upgrading investment can be considered as the antecedent of the study. (Harcsa, 2016/a). At present, there are about 140 commercial and 500 subcontract distilleries in Hungary, they produce 2 million and 9 million liters of distillate, respectively, with 50 vol % in the distribution of production. (I1)

Because of the legal changes of the previous years, the market for subcontract distilling has been declining since 2015 (Harcsa, 2016/b; I2). We intend to determine the brake even quantity by analyzing the data of a specific, but average subcontract distillery. Typical data of an average distillery are the following:

1. Rural location. According to Kovács et al. (2015), based on the New Hungary Rural Development Program (NHRDP), every settlement below 10 000 inhabitants is rural, and the districts where the population of the central city is more than 10 000 inhabitants, but the population density of the district is below the national average (107 persons/km^2). In January 2019, the list of updated subcontract distilleries recorded 558 units, of which 400 were in rural areas (I3).
2. Size of the micro or small enterprise. The number of employees is less than 10 people, the sales revenue or the balance sheet total is less than € 2 million (I4). Of the above-mentioned subcontract distilleries, only three were found to be irrelevant.
3. Traditional small pot technology is used with a capacity of 500 liters.
4. Energy supply was mainly based on wood and electricity.
5. It works seasonally, as distilling can be carried out after the ripening and mashing of the fruits.
6. The resulting by-products are utilized by soil management. Currently, this is the only cost-effective way to use. (Békési - Pándi, 2005)
7. The fee of distilling is between 500-850 HUF/litre (calculated for 1 litre of 50% vol. distillate), based on the data on the websites of the individual companies.
8. Official checks carried out by the National Tax and Costoms Office (NTC).
9. Compulsory use the distilling diary.
10. Provides only a subcontract distilling service, the product may not be commercially available. (Act XLVIII. of 2016).
11. The owner or employee should be qualified at least National Training List (NTL) Fruit palinka maker.
12. It must be in possession of the necessary authorizations for the operation (ÁNTSZ, NÉBIH, Fire Department, Water Management Directorate, notification obligation at the local government, etc.).
13. The subcontract distillery does not have its own basic material (fruit), it is provided by the customers.

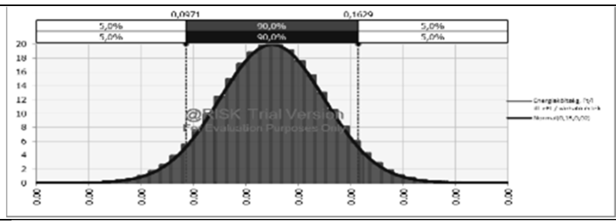
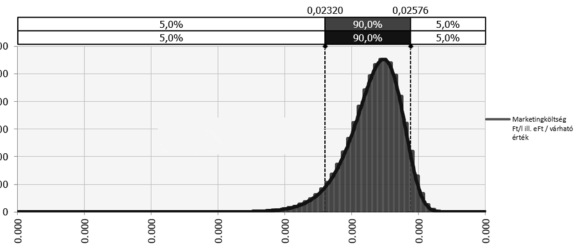
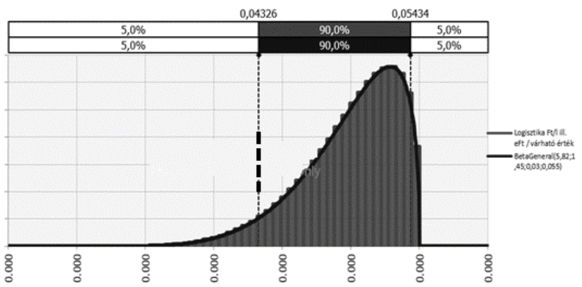
14. As a separate service, it occasionally performs mashing, delivery, or provide advice.
15. In the case of commercial plants, the excise duty is paid by the distillery at 100%, while in the case of the subcontract distilleries the tax is 50% and paid by the customers.
Effect of influencing elements (costs and revenues, as independent variables) by varying a threshold intervals are studied to the cover costs, as dependent variable, during the determination of the dynamic margin calculation In terms of statistical reliability, this can only be achieved by stochastic also a large number of simulations Lakner et al. (2014) made model calculations based on expert estimates using their price-cost-margin-profit models for *commercial* distilleries. No such model calculation has been carried out for *subcontract* distilleries. The most widespread method of subcontract distilling is the batch distillation process, (small pot, in Hungarian: "kisüsti") the essence of which is that we get first low-alcohol from the mash and then it will be refined. Kassai et al. (2016) found that the vast majority of pálinka distilleries are subcontract distilleries. Adapting the ideas of Lakner et al. we have developed a simulation model which is suitable for the analysis of a cost-benefit-profit of subcontract distilleries. By applying this method, it is statistically validated to show how much the income can be realized by a brewer operating under average conditions, which factors primarily affect its magnitude, and what kind of output (distillate) they can make.

2. Material and methods

Our work attempts to determine the margin amount in a dynamic approach. Baseline data were obtained from the database of Hun-Dest Drink Kft. Generally, businesses refuse to release their own internal data. One of the authors belongs to one of the family interests of this company, so getting to know its cost structure was not a problem. This company fully comply with the conditions listed above. The operation of the distillery and its various economic parameters are affected simultaneously by several factors. Consequently, an approximate picture of the profitability of the distillery can be obtained by examining the influence of input and output relations on the economic indicators of the distillery in various ways. An obvious tool for the analysis is to predetermine the parameters (distribution type and characteristics) of the factors affecting the examined parameters (such as cost, profit), and then to estimate the values based on the combination of values from each generated distribution. During the analyzes, we followed the logic outlined above, characterized by independent, pre-estimated random distributions of variables affecting the economic parameters of the distillery (production volume, production costs, etc.). According to Vajda and Kasza (2017), @RISK software is widely used in risk analysis. The plugin integrates with Microsoft Excel and allows to consider multiple scenarios using simulation modeling. In the case of interrelated variables, some combination of the values of the variables and their joint change in their parameters can be determined by scenario analysis. Building on a consistent combination of variables, scenario analysis provides a more accurate definition than a pessimistic

or optimistic value (Illés, 2009). Calculations were made using the @Risk 7.5 software package (Dikmen - Birgonul - Arikan, 2008). After performing a minimum of 1000 simulations, it was possible to examine the results mathematically and statistically.
The main objective of this study is to explore the cost-income relationships of an average subcontract pálinka distillery as an economic enterprise.
The research analyzes the costs of operating the pálinka distilleries, and then the income from the distillation, using model calculations based on factual data. The following boundary conditions were taken into account during the tests.
1. The distillery is legally operating in accordance with the Hungarian laws and regulations in force.
2. According to expert estimation, the value of the building and the equipment used in the case of a small pot system is in the range of HUF 5 - 5 million. The annual depreciation of buildings and structures was set at a depreciation rate of 2.5%. Technological machinery and equipment were depreciated at a rate of 4% per annum.
3. The distillery does not buy the raw material (mash), it is made available by the customers. Consequently, the cost of producing the raw material was not calculated.
4. The purpose of the distillery is to make distillates from the raw materials made available and supplied by the clients. If requested by the customer, the brewery will deliver the mash to the distillery within 30 km from the customer for a separate service charge.
5. In the breakdown of costs, the general practice of the Hungarian Accounting Act and the rules of domestic corporate costing rules were applied. However, for the sake of economic clarity, the process cost principles and approach have been implemented wherever possible.
6. Obviously, there are significant differences between the cost-income ratios of distillation, depending on the resource combination used by each distillery and the cost of each resource; and the efficiency of their exploitation. The investigations are basically based on the specific data of Hun-Dest-Drink Kft's distillery, which is approximately representative of the average subcontract distillery in Hungary.
7. During the calculations one main average number of employees was established. Wages were set above the minimum wage due to the expected 12-hour work schedule.
8. During the research, the price-cost-margin-profit calculation was carried out according to a standard system widely used in agricultural higher education (Nábrádi-Felföldi, 2007). In order to explore the role of production volume in profitability, individual cost factors have been split into fixed and variable costs. On this basis, it was possible to determine the profit. Based on the relation Ny = Q × (Á - Vk) – ÁK; where Q - total production (distillate); á - revenue per unit of product; Vk - specific proportional cost, ie proportional to the volume of production; Ak - the total cost, that is to say, the fixed cost between the lower and upper limits of the production volume examined.
9. An estimated value and an estimated standard deviation for each cost factor and revenue were established when creating baseline data for the studies. Where

deemed necessary, assuming "truncated" distributions, the value of each factor could not fall below a given minimum level.
During the simulation studies, the estimated values were approximated by varying distributions. We used ß general distribution for fixed and variable logistics costs, wages, marketing, variable energy, variable marketing, and depreciation of buildings and machinery. For fixed energy costs, a normal distribution was determined, while for corporate overhead, a gamma distribution was determined (Figure 1).
The individual distributions are considered expert advice and delimitation of extremes. For this reason, Weibull, Beta and Gamma distributions should be used in addition to the normal distribution. The distribution functions as well as the initial data of the simulation together provided the conditions for performing thousands of stochastic simulations with the model.
Sampling was performed by using the Latin hypercube method, which ensures that the random sample represents variability (Van Dam et al., 2007; Körtvélyesi, 2012).

Name of the function and the type of the distribution	Figure of the distribution
Energy cost Normal distribution	
Marketing cost Weibull distribution	
Permanent logistic cost Beta-genral distribution	

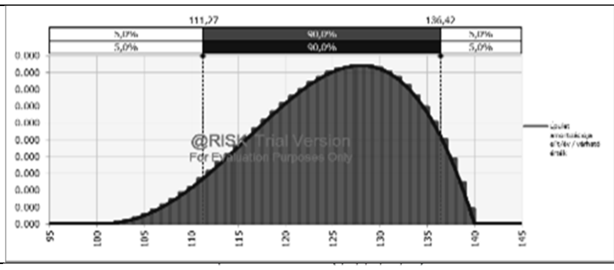
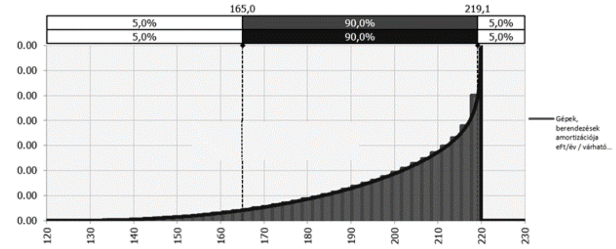
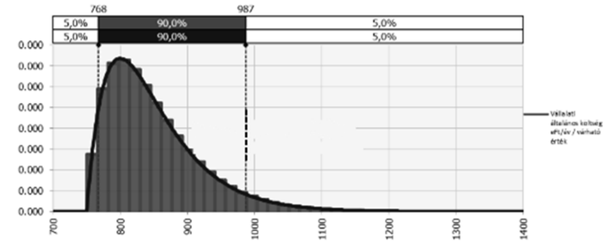
Name of the function and the type of the distribution	Figure of the distribution
Building amortization Beta-genral distribution	
Amortization of machinery equipment Beta-genral distribution	
Corporate overhead cost Gamma distribution	

Figure 1: The distribution functions of the simulation investigations.
Source: own editing.

Table 1: The initial data of the simulation.

Denomination	Variable costs			Fixed costs		
	expected value	variance	minimum value	expected value	variance	minimum value
Production volume, litre	15000	5000	5000			
Wage cost, thousand forint				3000	300	2400
Energy cost, forint/litre or thousand forint	13	2	10	500	72	360
Marketing cost, forint/litre or thousand forint	25	7	15	200	30	180

Denomination	Variable costs			Fixed costs		
	expected value	variance	minimum value	expected value	variance	minimum value
Logistics, forint/litre or thousand forint	50	3	20	120	10	100
Building amortization, thousand forint per year				125	12	100
Amortization of machinery equipment, thousand forint per year				175	20	125
Corporate overhead cost, thousand forint per year				800	80	750

Source: own calculation.

A large part of the energy cost is due to the high basic monthly charges so called "Availability fee", but in the case of any kind of problem the service providers give priority to these customers when troubleshooting. The highest proportion within the energy cost is represented by the heating energy. A distillery that wants to meet its customers' needs as much as possible must deal with logistics as not all customers can transport their mash. In the fixed part of this cost element the permanent costs relating to the vehicle (automobile tax, mandatory vehicle liability insurance, service, etc) are indicated. In the case of smaller subcontract distilleries the application of marketing can be observed. Pre-negotiated contracts can achieve better prices in media. At the same time, applying the principle - "If business goes, it is worth advertising, if it does not go, must be advertised"-, in case of higher production it is worth making extra marketing expenses, therefore marketing costs are also indicated among the variable cost elements.

3. Results

It has been verified that the cost of distillation, considering the results of 1000 simulations - including the extreme values - can vary between 331 and 1068 HUF per litre, and the average cost price is 545 HUF/litre. This is illustrated in Figure 2, where the empirical distribution of the cost is shown in light gray, and the solid line is represented by the fitted theoretical distribution, which is an Invert Gauss distribution.

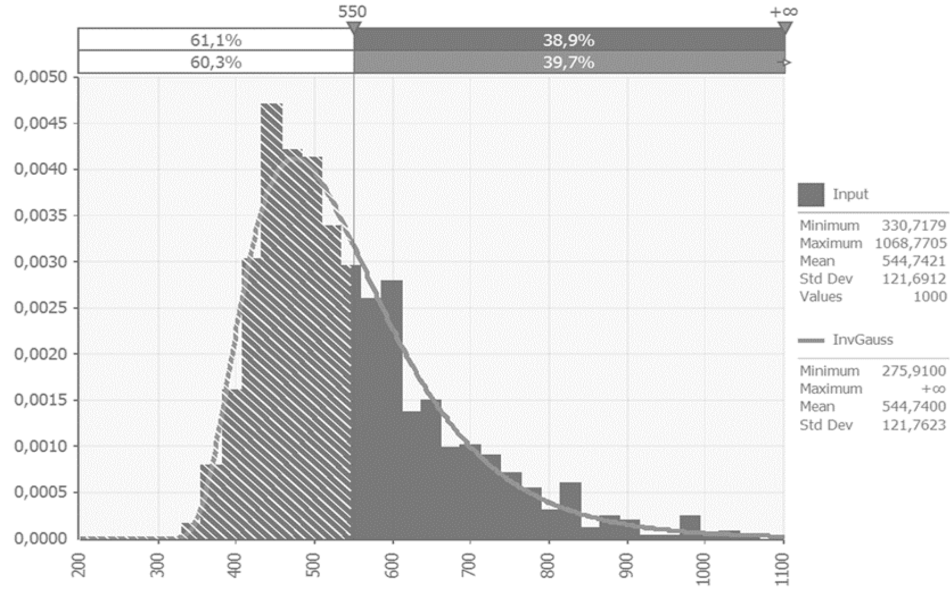


Figure 2: The first cost density function and histogram of the examined subcontract distillery based on 1000 latin hypercube simulations.
Source: own calculation.

The relatively high average cost of distilling (545 HUF / l) calls attention to the fact that in normal circumstances the possibility of earning “dancing on the edge” as the service fee is currently around 550 Ft / l. Based on the empirical distribution of the simulations, it can be stated that there is a 61.1% probability that the cost price below the HUF 550 coverage level can be expected, ie the distilling is profitable. If this revenue factor cannot be increased, then it will be necessary to examine how to reduce expenditure and to analyze how far the specific fixed costs can be reduced by increasing output, ie by increasing distillation quantity. The following two figures illustrate the excess emissions; Figure 3 and 4 illustrate the effect of all these.

Figure 3 shows that increasing output will reduce cost. That is good, but there are a few things to note. The output cannot be increased indefinitely, since physical capacity (technical capacity of the distillery), human resource capacity (palinka master, staff) and ordering capacity (consumer demand) all affect the quantity of produced distillate. In principle, cost reduction can be achieved by increasing output, but in practice it is not, or very difficult to implement.

Figure 4 shows the percentile values, expressed in % of output as a function of the cumulative probability distribution of cost. During the simulation, seven percentile values have been recorded. In the case of maximum capacity utilization, the cost analysis was carried out at 99%, followed by a decreasing rate of 95%, 75%, 50%, etc. The results spectacularly show that increasing production can significantly reduce the cost of producing distillate by up to 30% of its original value.

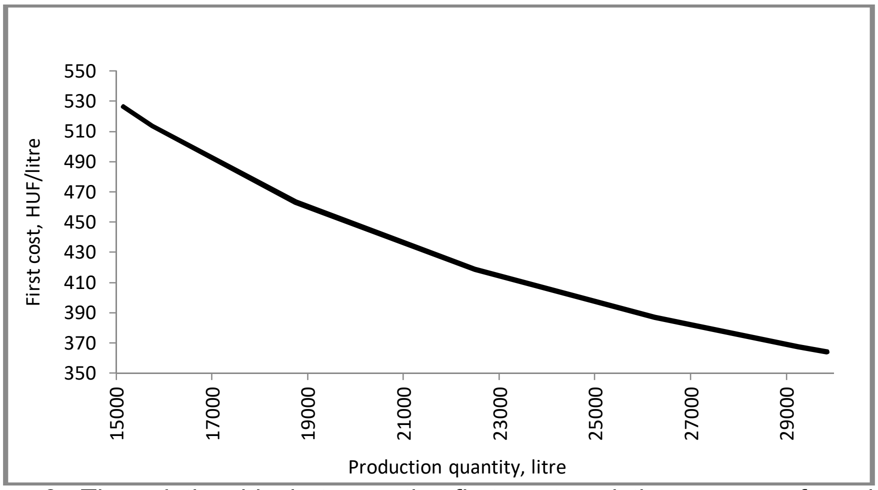


Figure 3: The relationship between the first cost and the amount of produced distillate based on 1000 latin hypercube simulations.
Source: own calculation.

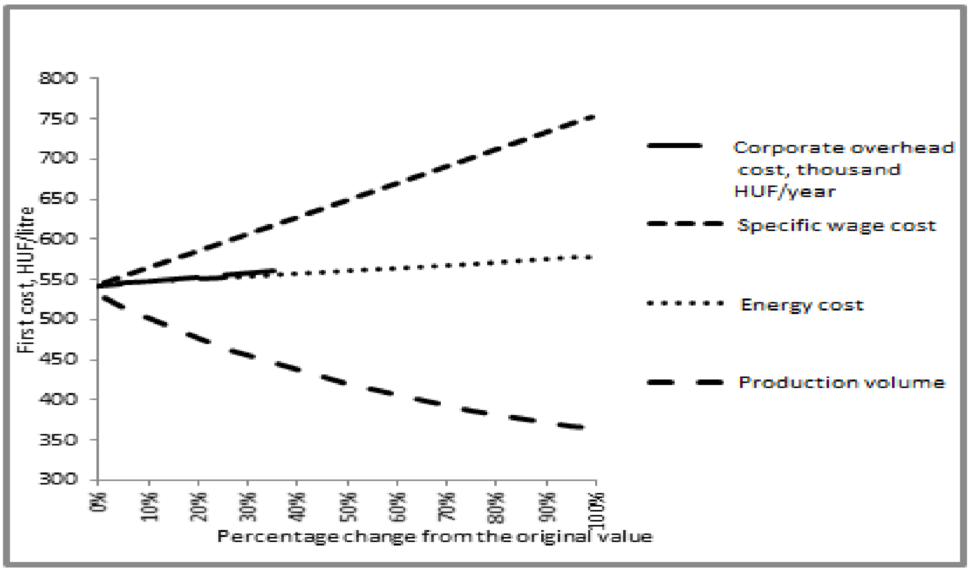


Figure 4: The cumulative distribution of the first cost depending on output based on 1000 simulations.
Source: own calculation.

Examining some of the factors affecting the first cost, it was found that there are four determinants (cost element and production) that have a decisive influence on the cost of distilling. In a downward direction the output (produced distillate) and in ascending direction unit labor costs, energy costs and overheads. The relationships between these factors are shown in Figure 5.

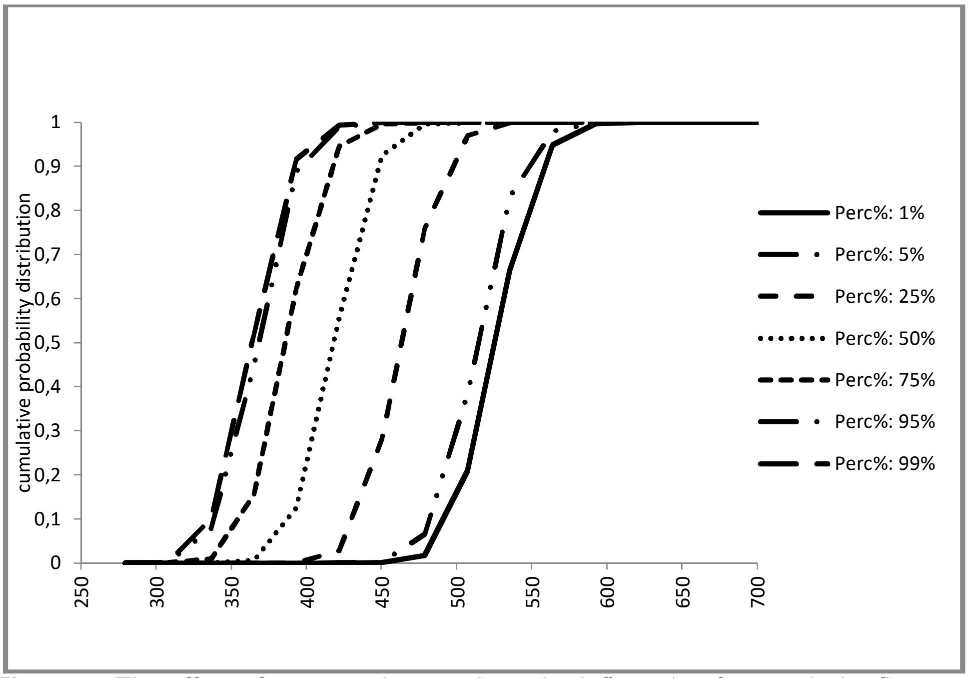


Figure 5: The effect of percent changes in major influencing factors th the first cost based on 1000 simulations
Source: own calculation.

There is a strong correlation between first cost and income per liter. According to the results of the simulation, with a 90% probability, it can range between -239 and + 150HUF / liter (Figure 6). Similar to first cost, there is an approximately 60% probability of positive income from distilling activities.

The effect of unit labor costs, production volume, energy costs and overheads on the cost of production were also studied. The process of the sensitivity analysis was the following: For each of the 4 factors, seven percentiles of their distribution were considered (1,5,25,50,75,95,99). The value of a given factor in the sensitivity test line was recorded at the appropriate percentile, while the values of all other factors were sampled from the theoretical distribution with 1000 iterations according to the principle of Latin hyper squares. Then tthe average cost per 1000 iterations was calculated and then the whole analysis for all percentiles were made. Thus, for each factor, there were 7*1000 simulations, and for the four factors, a total of 4*7=28 sensitivity analysis. The sensitivity tornado diagram (Figure 7) shows the results of the 28 sensitivity tests separately for each variable and shows the range over which the average of 1000 simulations is applied using each percentile.

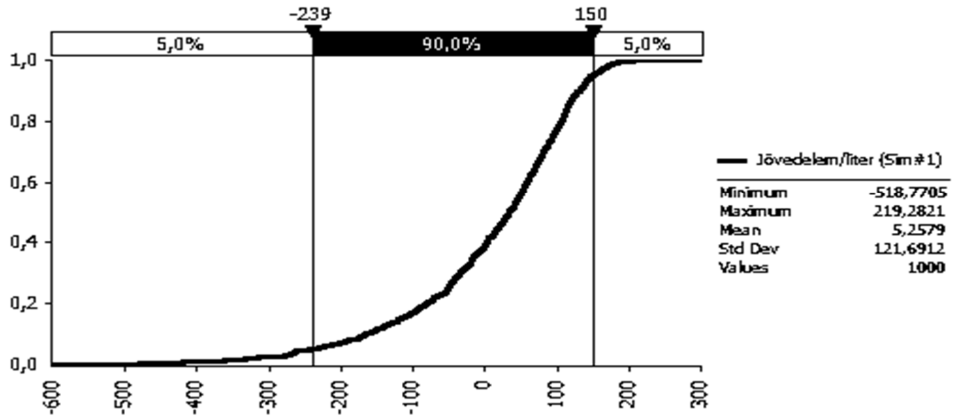


Figure 6: The saturation curve of income, HUF/litre.
Source: own calculation.

The tornado diagram shows the factors influencing first cost, in order of their relative importance. The change in unit labor cost was the most sensitive to the first cost, in the amount of HUF 205. If we take a very small distribution value for the production volume (1% percentile 15150) and a very high production volume (99% value 29850), we will only experience a HUF 162 fluctuation in the average first cost. The effect of the change in energy cost is HUF 33, while the corporate overhead costs affect HUF 23. It can be concluded that unit labor costs have the greatest impact on the first cost, while the impact of changes in energy and overheads is only one-sixth one-tenth of the cost of labor.

With simulation test setting 1% tolerance for the difference between revenue and expenditure, the production volume can be considered as a break-even point in 29 cases based on 1000 simulations. This was determined by a heuristic approach. Based on the mean of the production volumes of the 29 cases (Revenue-Expense~0) the break-even volume is 13,892 liters. This means that an average distillery must produce at least as much distillation per year as its revenue will cover its expenses. Based on the actual data, it can be conclude that in 2017, ~ 500 enterprises produced ~ 9 million liters of distillation, so the average operating output was 18 thousand liters.

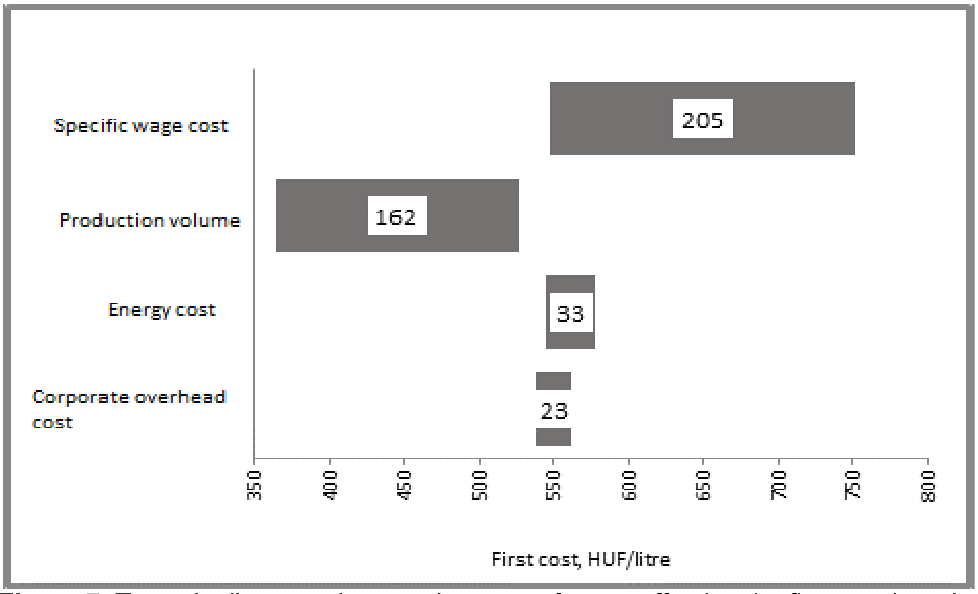


Figure 7: Tornado diagram, the most important factors affecting the first cost in order of importance.
Source: own calculation.

We can also conclude that distilling is a revenue generating activity. But this number is just an average. There are businesses where this output is feasible, some of them are cannot reach this. The fact is that the lack of customers compared to the tax exemption period after the amendment of the excise law in 2015 is drastic and the quantity of distillate produced is decreasing.

4. Conclusions and proposals

If the distilleries have the opportunity, it is strongly recommended to apply a higher price level than the HUF 550/liter mentioned in the example. Theoretically, it is possible to increase the output, since this can only be realized in the case of distilling as a service if there is a consumer demand. The most important factor that can be influenced by the enterprise is the cost of labor. Due to the high contribution burden, it is advisable to continue making palinka not as a full-time job but as an additional income generating activity. In addition, energy costs and overheads have an impact of between HUF 24 and 33 per liter when compared to the HUF -239 and +150/liter available income points to the fact that lowering wage costs and increasing output could raise the income. However, there is only a 60% probability of positive income from subcontract distilling.
The break-even quantity has been determined as 13.9 thousand liters, which, although on average distilleries exceed, but the trend is that the volume of distillation

produced by subcontract distilleries after a change in excise law in 2015 has fallen well below previous levels.

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