SELECTED CHAPTERS OF CORPORATE FINANCE AND RISK MANAGEMENT

Edited by Barbara Dömötör and Kata Váradi

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Corvinus University of Budapest
Budapesti Corvinus Egyetem

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Preface

This book was prepared for the Finance Master program of the Corvinus University of Budapest started in the academic year 2019/2020. The book consists of two main parts, the first part deals with corporate finance and financing issues, while the second part covers risk management and liquidity management in financial markets.

The cases in this book highly build on the knowledge base of the master's program curriculum, therefore, it is imperative for students to familiarize themselves with the basic notions first, before starting to solve the exercises. If you experience any knowledge gaps, then refer to the regular textbooks before solving the cases.

In several cases, the related regulations should also be read in conjunction with the case in order to be able to understand and solve the exercises. This highlights the ever increasing relevance of regulation in the finance industry.

Apart from the knowledge of the financial notions, and related regulations, students should also be skilled in using spreadsheets, since several cases cannot be solved without it.

We recommend the book both to master's students in Finance and to practitioners as well.

The Editors

Content

Part I: Corporate Finance

1. FINANCIAL CALCULATIONS: ANNUITY

Gergely Fazakas

Aim and theoretical background

Annuities, special cash flow-series are interesting problems not only in the corporates' life but in everyday life as well. Possible calculations, estimations of the different parameters need analysis in detail.
Annuities and perpetuities have two meanings in English.
The first meaning is a mathematical problem, referring a special cash flow series. If it is an annuity, then we have constant cash flow at regular intervals for a fixed time period; if it is a perpetuity, then we have a cash flow at regular intervals forever. (See e.g. Ross et al. 2006, pp. 157–166.) In both cases the default scenario has the following assumptions:

- flat yield curve;
- same cash amount at each period (there is no growth rate);
- cash elements coming yearly;
- the first cash flow coming at the end of the first period.

The second meaning is a financial tool – we can call it an art of investment or from the other point of view as an insurance tool. The two parties – the investor and the other party, who gets the annuity – agree in a given cash flow-series, paid by the investor until the death of the other partner. The deposit behind this transfer or the compensation for this payment is the other partner's real estate – usually his/her home, he/she lives in.
So, this contract has an essential actuarial point of view. The key problems are:

– What is the fair value of the real estate?
– How long will the owner of the real estate live?

Of course, there is some additional problem to answer and to solve:

- Will be any growth rate in the cash flow-series? (E.g. inflation-adjusted)
- Is there any immediate cash flow to be paid?

- When can the investor use the real estate – immediately, just after the death of the other partner, or there are some other options?
- Is there only one person, who gets this annuity, or more – usually couples – and the investor has to finance this investment until both deaths?

This case study fits into one double lesson. Going through a complete problem we can analyze the whole theme. There is quite a short preface, just a short definition of the problem – and then there is a long list of questions. The ranking of these questions make the structure of the lesson – I believe, that using this guideline would make an interesting frame, and students could be interested in the popping up new problems. For this reason, I will not give all the parameters in the beginning – we can make a debate in the group, and then the group will end up in a democratic solution (with the help of the instructor) – or at least I hope so.

Case

We would make an annuity contract with uncle Steve – we will pay him a yearly sum until his death in exchange to his flat. Uncle Steve has a two-bedroom, 60 m2 flat in Budapest, on Pest side, in a small block of flats. This house was built ten years ago, standing on a 400 square-yard property. You cannot build any bigger real estate on that property – according to the construction rules of the district. The founding charter of the house declares, that the owners of the other flats do not have any preliminary right to buy other flats in the house. Uncle Steve has not any heir, he lives alone in his flat, he is 72 years old, and according to the estimations, he will live an extra 13 years[1].

Questions

1. Give an estimation to the value of the flat! What estimation method would you use for it?
    a. Multipliers?
    b. Present value method?
    c. Options?
    d. Substitution – reproduction value?
    e. Which estimation method suits for what type of investor?

[1] Another case study regarding the usage of a real estate can be found in Jáki (2017)

f. Is there any need to make a positive or negative correction in the values?

According to professional estimations the value of the flat is 40 million forints.

2. Is there any consequence of the founding charter about preliminary rights?

3. Why is it important, that he lives alone?

4. What is the required rate of return on this field?
    a. What is the required rate of return renting out a flat?
    b. Is there any other element generating extra profit / extra rate of return?

The required rate of return on this segment of real estate investments is 9% annually. (The inflation rate is 3%.)

5. Who will use the flat in the next 13 years?
    a. Uncle Steve will live in it.
    b. Uncle Steve will move into old people's home.
    c. We will pay a certain amount to Uncle Steve at the beginning, and he should move.
    d. How could you built these assumptions into the calculations?
        i. Would you build the effects into the value of the house?
        ii. Would you change the required rate of return?

We can use the house from the starting date of the contract, and Uncle Steve will move out to his relatives in the countryside, to the village called Hevesalso.

6. OK – so what would be our estimation for value of the flat and for the required rate of return?

7. In the contract we would declare, that we will pay a constant annual amount to Uncle Steve until his death. (So as to make an easy calculation, we will pay just once a year.) Overall we will count with a 13-element annuity. Let's get this factor (For example from an annuity-table). What is the fair yearly sum to pay?

8. Uncle Steve would take our offer. What happens, if we paid back the whole remaining debt? How much should we pay?
    a. What is the fair calculation using future-value method? (Paying interest + principal)

        i. Which cash flow element has priority – interest or principal?
        ii. What does this priority mean from legal point of view and from mathematical point of view?
    b. What is the fair calculation using present value-method?

9. Using annuities – what does our formula assume? We pay at the beginning of each period, at the end or in the middle of the period? Does it suit for our contract? Does it suit for renting flats?

10. Uncle Steve asks us to pay at the beginning of each year. We should recalculate the fair yearly payment.
    a. Let's use a 12-element annuity!
    b. Let's shift our original annuity!
    c. What is the ratio between the original payment and the new payment? (In percentage.) And what is the ratio between the 12-element annuity factor and the 13-element annuity factor?

11. Now we are able to calculate the fair monthly payment! We would divide the present yearly payment into 12 monthly payment.

12. What is the monthly required rate of return?

13. What is the fair monthly payment?
    a. If we pay at the end of each month.
    b. If we pay at the beginning of each month.

14. Let's turn back to the construction with the yearly payments. Let's assume, that Uncle Steve would take payments at the end of each year. We will pay 13 times, at the end of each year. What would be the first payment, if Uncle Steve asked inflation-adjusted payments? We assume a flat inflation rate at 3%.
    a. Let's use the real rate of required return.
    b. Let's use the formula of growing annuity.
    c. Is there any difference between the two results? (Did we use a fair real rate of return in our calculation?)

15. We will change our mind. We would pay a constant 5 million per year. How long should Uncle Steve live to get a fair contract? (Use excel or annuity table – but do calculate the annuity-factor first!)

16. Our next idea is to pay even less. Our offer is only 3.5 million forints per year. How long should live Uncle Steve to get a fair contact? How can we check our result with the help of payment-structure of the annuities (interest + principal)?

17. What is the value the annuity-factors go to in the column of 9%?

18. Taking this limit, what yearly payment is the theoretical minimum making a fair contract?

19. Uncle Steve takes our 5 million forints offer. We are quite happy, because we should pay a lower sum than the fair value. Great deal! (Uncle Steve will live for 13 years, in average). What is the internal rate of return of the contract? Is it higher or lower than 9%?

20. Let's explain the result and its relation to 9%!
    a. Is it an active or passive transaction?
    b. Is it investment or debt taking – financing problem?
    c. What do the words „investment" and „debt taking" mean
        i. for a lawyer;
        ii. for a book-keeper;
        iii. for an investor?

21. How do conventional cash flow series look like?

Let's use the following, very simple problems.

A. You invest 1 million forints today, and will get 1.1 million forints in one year.
B. You will take a debt: 1 million forints today, and you will have to pay back 1.1 million forints in one year.

22. How does the function of present value and net present value of a conventional cash flow series look like? (the independent variable is the required rate of return)
    a. In the case of debt taking? At what rates of return do we have positive and negative NPV-s? At what rate of return do we have the internal rate of return.
    b. In the case of investments? At what rates of return do we have positive and negative NPV-s? What is the internal rate of return?

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Most of the financial textbooks deals with annuities, like:

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2. BUYING A FLAT IN BUDAPEST

Gergely Fazakas

Aim of the case

Now, in 2019 we are very sorry, that we hadn't bought a flat five years ago – we just had not thought about it, or we could not have financed it. The financial crisis seriously affected the prices of flats in Budapest: the prices were stagnating between 2009 and 2014, or even they were descending by 10-20%. (E.g. see the flat price index from the National Bank of Hungary)
On the other hand, prices of flats in Budapest between 2014 and 2019 had been more, than doubled. Were we losing all the chances for a good investment? Would not have been a better idea to buy a flat previously using a bank loan? That is true, that meanwhile the currency-crisis only a few investors could have risked taking additional bank loans. (In those area banks were cautious as well, they would have landed loans only under very strict conditions.) But now we are in 2019, and thanks to the boom, we do have enough money to invest. We would like to buy a flat, and get a permanent income renting it out[2].

Case

The chosen real estate is in the 9th district of Budapest, it is a 50 m^2 small flat with two bedrooms. The house has very good transport possibilities: both metro line no. 3 and the tram 4-6 is very closed. There are 3 universities nearby.
The flat would be ideal for singles, young couples, or even for couples with one or two small children. After a short discussion, you could get the flat for a reasonable 35 million forints. The house was built 35 years ago, so not new – but both the house and the flat itself is in good condition. A normal painting (400.000 forints) would be needed anyway.
We would analyse different concepts, but one thing is essential: we are risk averted, so we will declare and pay all the taxes (15%) linked to renting out.
Painting out is urgent – we will be ready with it within a month. Meanwhile, we will be able to find a tenant as well. (The cost of advertisement will be somewhere between 5000 and 10.000 forints, the cost of our time included.) We

[2] Another case of utilization of a house can be found in Jáki (2017).

are planning to rent it out for 15 years – our older son will be eighteen by that time, and after a greater reconstruction he would live in.

Utilization

Let's start with utilization. We have two ideas.

a. We would make a long-term renting contract. We will get a suitable tenant within a month. The monthly fee would be 150.000 forints, unfurnished. Gas, electricity, water will be paid by the tenant – all those contracts will run under his name. We assume, that within the 15 years renting period there will be no greater reconstruction needed.
b. Our second option is Airbnb – as far as the flat is quite closed to the inner city. We assume that we will have guests 180 days a year, and can take four guests. The first day of each transaction would cost 18.000 forints, each additional day would cost 14.000 forints. At this case, we should buy furniture and household appliances. At the arrivals of the guests, we should clean it up and welcome them.
   Our plan for renting out through Airbnb as follows:

Table 1. The Airbnb renting out plan

Month	**Days rented out**	**Number of reservations**
January	11	4
February	8	3
March	13	5
April	15	5
May	18	6
June	20	6
July	22	6
August	22	6
September	16	5
October	9	3
November	8	3
December	18	6
Sum	**180**	**58**

Costs

Whatever would we use the flat for, we have to pay a 4% fee on the buying price. Water, gas, electricity cost 40.000 forints per month – if the flat is rented out, the tenant should payit. We have to pay a general overhaul, which makes 10.000 forints per month.

a. We would sign the long-term contract at a lawyer – this would cost us 100.000 forints. We hope, that within the 15 years renting period there will be no extra reconstruction cost – but smaller or bigger replacement cost will be needed in the value of 50.000 forints per year.
b. Renting out through Airbnb needs 40.000 forints immediate investment at registration – mainly because we want professional photos about the flat. At the arrival of each guest we have to clean it up and welcome the guests – there is a firm specialised in it. It will cost 4000 forints each time. Airbnb asks 3% on the turnover.

The list of investments needed is here.

Table 2. Investments needed for Airbnb

Item	**Cost (1000 Fts)**	**Depreciation**	**Lifecycle (years)**
Kitchen appliances	900	33%	3
Bathroom	500	20%	5
Furniture	2500	20%	5
Hifi, tv, electrical machines	600	33%	3

If we have to buy new items, prices are going up by 3% yearly according to our estimation.

All the costs are tax-deductible (if we do not choose the lump-sum method.).

Costs – taxation method

We can choose from three different taxation method.

a. We can choose detailed taxation. In this case, we can deduct all single cost-item from revenue. The depreciation can be deducted as

well –this is 2% on the flat and 14,5% on the furniture and appliances. Choosing this possibility we have to ask a book-keeper to help us – this would cost 10.000 forints monthly.

b. We can also choose the "lump sum" method. In this case, 10% of the revenue can be the total cost, so as 90% of the revenue will be taxed. No extra costs can be deducted from the revenue. (NAV, 2017)
c. Taxes on rooms. There is a special rule: if the rooms are rented out a maximum 180 days a year, you can choose this method. This case the yearly tax is 38.000 forints per room. (So 76.000 forints for our flat – as far as we can rent it out the whole in one.) You have to pay it at the beginning of each fiscal year.

Terminal value

At year 15 we would give the flat to our older son. At this stage, the flat will be in medium condition. On the real estate market, we presume a 3% yearly inflation rate.

The required rate of return

The required rate of return on renting out a flat is 8%.

Using Airbnb is riskier because we have to face with country-risk, exchange rate risk and higher operative risk as well. In that case, we can use a 10% rate of return.

Questions

1. Can you give an estimation for the future cash-flow for the next 15 years month-by- month?

2. What are the NPV and the Internal rate of return of each scenario? Which possibility gives us the highest values?

References

Jáki, E. (2017). Kertvárosi ház hasznosításához készített megvalósíthatósági tanulmány, in Jáki, E. (2017). Üzleti terv pénzügyi vonatkozásai. Befektetések és Vállalati Pénzügy Tanszék Alapítványa, Budapest, pp. 18-30.

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3. HOW TO FINANCE: BUYING A FLAT IN BUDAPEST

Gergely Fazakas

Aim of the case

We are now in 2019. On the Hungarian market, flat-prices have been growing by roughly 20% annually in the last 5 years. Although it can be a risky investment, we have decided to buy a flat and rent it out on a long run. According to some experts, the prices are on the top just now, and a recession can be expected within 1-2 years. We cannot finance such a business ourselves, but our brother-in-law (who has a wide portfolio of different real estates) is ready to take part in our project.

This case is dealing with different financing methods.

The chosen real estate is in the Inner district, the 6th district of Budapest. It is a 60 m^2 small flat with two bedrooms. The house is in a walking distance from the old underground (called Kisföldalatti) line and from the trams on Grand Boulevard (in Hungarian Nagykörút).

We could get it for 40 million forints – this price is quite favourable, although the flat is not even in the "medium condition". Our reconstruction expert estimates the costs of the reconstruction as 8 million forints – he can start the works immediately and within two months they can finish the whole project. Although there are several possibilities to finance the project, one thing is essential: we will be the only owner, we ourselves will pay all the costs, and all the taxes linked to the flat will be declared and paid.

The renting-out is planned for 10 years – that is the maximum time horizon we can make financing plans and our brother-in-law would like to exit by that time.

1. Utilization

We have agreed with our brother-in-law to make a long-term renting contract. The flat is suitable for diplomats, young managers or young couples. We believe that for 200.000 forints renting fee (unfurnished) we would easily find a reliable tenant (within a month).

We would ask a 2-month deposit as well. Gas, electricity, water will be paid by the tenant – all those contracts will run under his name. We assume that within the 10 years renting period there will be no greater reconstruction needed.

2. Costs

Buying a flat we have to pay a 4% fee on the buying price. Water, gas, electricity cost 40.000 forints per month. We have to pay a general overhaul, which makes 10.000 forints per month. We would sign the long-term contract at a lawyer – this equals one-moth renting fee, so 200.000 forints. We hope, that within the 10 years renting period there will be no extra reconstruction cost.
All the costs are tax-deductible – if we choose the detailed cost-deduction tax method.

3. Costs – taxation method

We can choose from different taxation methods. We could have chosen the detailed taxation method, but our brother-in-law hates the meticulous administrative tasks – so we will use the "lump-sum" method. In this method, 90% of the revenue is the tax base, and no real costs are tax deductible (NAV, 2017; Ado, 2018).

4. Financing

We have two ideas to finance the buying price and all the extra costs.

a. If we finance the whole project ourselves, we would need the help of our brother-in-law. He is ready to pay 50% of all costs and investments, and he would ask 50% of all the incomes after tax. At year 10 he would exit, so we will have to buy the 50% ownership.
b. We would take a bank-loan. The loan would be 10-years long, payment due monthly. The interest rate would be 6% yearly (on a linear basis). The cost of the loan 100.000 forints, immediately payable (e.g. cost of the notary).
   The only collateral behind the loan is the flat itself. The bank can give us a loan up to 50% of the value of the flat. Although sometimes asking a loan is quite a long and difficult process, thanks to our connections and experience we could get in within

some days. About more details of mortgage and other retail loans and the loan approval process see: Walter (2016) or Jáki (2018).

5. "Baby-bond"– state aid for young couples with children

There is a state aid – a special loan – for young couples with children. We have a son, so we can get this special loan. We can get 10 million forints as a loan for 10 years – paying back monthly as an annuity. The 1st children means, we do not have to pay any interest. We will have our 2nd child at the end of the 2nd year. The 2nd child means that 30% of the original amount of the loan will be wiped out. Asking a Baby-bond" is not so easy, the time and administration would cost 50.000 forints for us.
The Baby-bond can be combined with the "normal" bank-loans as well.

6. Terminal value

At year 10 we will think about the usage of the flat. It can happen, that we would buy out our brother-in-law, but also a possible scenario to sell the flat together. At this stage the flat will be in medium condition. On the real estate market we presume a 4% yearly inflation rate. Nowadays flats in medium condition are priced 10% lower, than average. A newly renovated flat would cost 10% higher than the average. We presume, that there will be a 4% inflation on reconstruction costs as well.

7. The required rate of return

Renting out a flat is not riskless at all. The long term risk-free rate of return is 4%, and we will calculate a 6% market premium.
To live in a flat is an inferior need, so the rate of return on renting out will be below the market rate of return, just 8%.
If we are taking a bank-loan, we assume that the loan is risk-free. The bank had so many and o strict collaterals and restrictive rules, that they will not risk anything. For simplicity we suppose that 50% of the investment will be debt-financed.

Questions

1. What is the future cash flow for the next 10 years month by month?

2. What are the NPV and the Internal rate of return of each scenario? Which possibility gives us the highest values?

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4. ACQUISITION FINANCING – DAC CORPORATION

György Walter

Aim and theoretical background - Structured finance[3]

The aim of the following case is

- to analyze the different risk aspects of acquisition financing;
- to understand the business concept and model of IT companies;
- to carry through and acquisition finance approval process, and
- to make a decision on its possible structure, terms and conditions.

The term of „structured finance" is difficult to define. In some definitions, it is a transaction where the risk analysis and financing decisions are not based on the balance sheet and the assets of the company but on the forecasted cash-flow. It is a product where the transaction and its financing must be structured tailor-made to meet all requirements and expectations of the stakeholders and participants. These transactions usually involve high leverage, high risk, longer and more complex preparation, a thorough due diligence process, analysis of the cash-flow capability, and a more complex contractual and legal structure. Based on the literature, the most important groups of structured finance are as follows (Jobst, 2005, pp. 19–21.):

- High leverage financing (like acquisition financing)
- Project financing (like real estate development, energy projects, etc.)
- Securitization
- Structured trade finance

On the corporate level most of the transactions belong to the first two groups, to high leverage financing and project financing. The sale of these products is not only typical in commercial banking but merges with other services of investment banks like advisory, syndication, origination. Therefore, investment banks and corporate finance firms are also active participants of such

[3] See Walter (2014b)

transactions joint by technical and other special advisors, legal firms, auditors, etc.

Transaction types that belong to the group of high leverage financing are as follows:

- Acquisition financing
- Leveraged Recapitalisation (Recap)
- Leveraged asset-based finance

Among these groups, acquisition financing is possibly the most frequent transaction. It is about buying a whole (or substantial part of a) company, therefore the volume of the transaction is high. It usually involves debt financing resulting high leverage at the end.[4] The acquisition loan and its repayment schedule appear as a new, considerable burden on the company that is added to all former debts of the company. The high leverage must be paid back based on a tight cash flow plan.

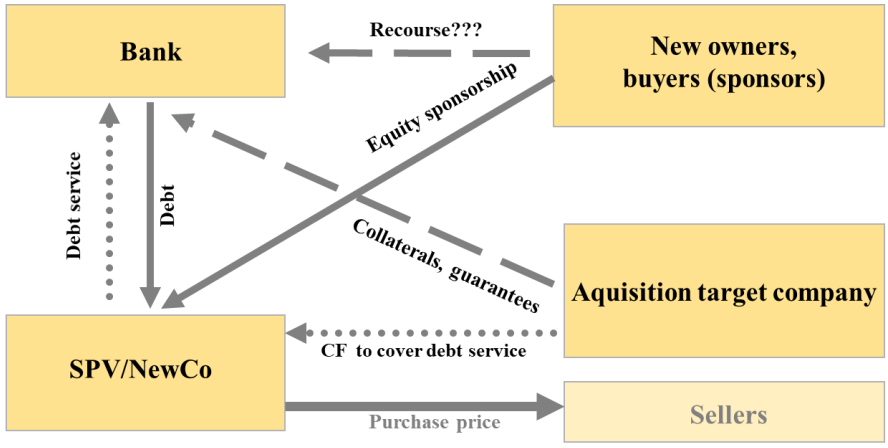
Acquisitions usually include complex structures with many participants where different types of conflicts of interests arise. There is a potential new investor accompanied by a bank who both face high risk. To mitigate these risks other players also step in, whose tasks, interests and conflicts must be also managed and coordinated. The potential participants in a transaction are:

- New owners, investors, the buyers;
- Former owners, the sellers;
- Banks and other financing institutions (factor firms, leasing companies)
- Mezzanine funds
- Legal experts, legal firms;
- Technical, tax, environmental, PR and other advisors, experts;
- Corporate finance advisor of the seller;
- Corporate finance advisor of the buyer;
- Auditors
- Authorities
- …

[4] There could be a connection between acquisition financing and IPOs too, see Szabó and Szűcs (2014).

Transaction structures could be various, tailor-made to the certain deal. The figure below shows one of the simplest and commonly used financing and contractual structures of an acquisition.

Structure of an acquisition financing



Source: Walter (2014b)

The provision of the loan is prior to the change of ownership. Therefore, it is difficult to solve – from the structural point of view – how the acquisition loan "is put inside" the target company and how it is linked to the cash-flow, to the assets and the collaterals of the operating company. In most cases, a special company is needed (an SPV, that is a „special purpose vehicle"), which takes up the loan, gets the equity sponsorship of the new owners, pays the purchase price, and receives the stake, the ownership (shares, equity) of the target company. The SPV is usually a non-operating company, it holds the equity of the target company, acts as an owner, receives the necessary cash-flow from the company to be able to provide the debt service of the acquisition loan. This structure implies several technical, tax, accounting, and legal issues and problems, like: how and based on what cash-flows are flowing from one company to the other; how collaterals and guarantees can secure a loan of another company. To solve these problems target company and SPV sometimes merge, though it usually takes several months to close up such a merge process. All sponsors, especially financial investors, try to avoid any recourse financing and intend to limit their liabilities to the volume of the equity sponsorship. However, industrial investors are more likely to accept a recourse financing and

shows more flexibility to back the new acquisition loan with its balance sheet, cash-flow, or with a corporate guarantee. In the case of MBO transactions, personal guarantees of the new owners, as a proof of commitment, are also an accepted practice and it usually plays an important role in the success of the deal.

Case – DAC Kft.

Dominika took the document from the table. She blinked at the monitor. It was the 17th of September 2007. Monday, 9.13 a.m. She was the head of the Structured Finance Desk and has had quite a lot to do nowadays. First, the Bank Headquarter had several questions concerning the real estate crises that got surprisingly bigger and bigger on the market. Filling the reports to the headquarter consumed a lot of energy and time. On the other hand, there were many transactions in the pipeline and she wanted to do all of them. But only if they are feasible, of course. The current deal described in the document was a typical, small, local acquisition loan, where almost the whole documentation was ready. Most of the business and cash-flow scenarios were done, the credit application was almost complete, only a few parts were missing, these were all highlighted with yellow.
She carefully read through the whole credit application.[5]

[5] For definitions and terms of credit application see Walter (2014a).

Credit application

CREDIT DECISION REQUIRED BY:	
Transaction Name:	DAC Deal
Transaction Details:	MBO of a significant actor of the document archiving, document management and workflow management market
Underwriting Requirement:	**A.** Senior long-term loan HUF 128.8 million **B.** Credit line HUF 10.0 million **C.** Guarantee HUF 5.0 million
Available documents:	• Business plan for 2007-2012 • Annual reports of DAC, 2001-2006 • Balance sheet and P&L of the first half of 2007 • Information Memorandum • List of references • Description of the activity and the products • Integrator contract signed with TELCO1 and with PRINTCO Rt. • Exemplars of delivery contracts, support contracts and software update contracts • Drafts of contracts to be signed with TRASPORTCO

Introduction – Transaction Background

DAC Kft. is a market leader in the Hungarian document archiving/management and workflow management segment. Current owners of DAC Kft. have decided to offer the Company for sale to a strategic buyer. One of the present owners, Mr. Balázs Vezér (as a preemptive right) would like to get 100% ownership of the Company. He intends to finance the deal at leverage, and requested a long-term EUR loan to finance the transaction. Furthermore, he also intends to get a

credit line in order to match the financing of temporary given orders and contracts.

Transaction Structure

Current structure

The Company's ownership is currently shared by three Hungarian private individuals, namely Mr. Béla Owner with a quota of 40%, Mr. Balázs Owner with a quota of 40% and Mr. Balázs Vezér with a quota of 20%. Mr. Vezér is also a member of the management.

New structure

According to the plans of Mr. Vezér, DAC Kft. becomes a single-owned company. The total purchase price is HUF 184 million, and Mr. Vezér intends to finance 70% of the purchase price at leverage. The total amount of loan provision is equivalent to HUF 128.8 million, currently EUR 511 thousand in single draw-down. Consequently, about half of company value is financed at leverage.

Mr. Vezér intends to purchase the remaining 80% of the Company's ownership through a project company. Current owners of DAC will sell their quota to the project company of Mr. Vezér through a foreigner project company. After the transaction (planned to take place until the end of 2007) the project company and DAC merge, so that DAC gets the loan.

Company Overview

DAC Kft.

DAC was established by three Hungarian private individuals (Mr. Béla Owner, Mr. Balázs Owner and Mr. Balázs Vezér) in 2000. Two of the founders, Béla and Balázs Owner have been involved in the optical and image recognition sector since the early 90's, and are founders of several IT companies. Mr. Vezér is the CEO of the Company since its foundation. He graduated at the Technical University of Budapest, and started to work as a developer for several companies during his university years. He also worked for FAC, a company owned by Mr. Béla and Balázs Owner, of which DAC grew out.

DAC Kft. is active in the document archiving/management and workflow management sector. In the first year after establishment, DAC was providing an archiving and document management product for small and medium size companies. Shortly after the beginning, the Company's focus changed to

provide software products for large enterprises. Currently, DAC produces and sells document archiving and management software product under the brand name CLEVERARCHI, and does the integration of the software with customers' Enterprise Resource Planning systems. DAC also performs the customization, regular product updates and support over the life of the contract. DAC's proprietary office automation solution has been sold to over 100 companies in Hungary. This product (the software CLEVERARCHI Digital Office) was designed to perform complex document archiving and management functions for medium and large size organizations. Suiting the needs of customers, DAC provides efficient, quick and secure filing, archiving and management of physical and electronic documents. It enables not only the storing but also the quick retrieval of mailing and other confidential data. The distinctive feature of CLEVERARCHI in this field is its rapidity and reliability (e.g. retrieval is performed in seconds in case of order of magnitude for millions too).

The main functions the software has are the following:

1. Filing/registry: The software fully replaces traditional filing/registry methods. It can handle registries of arbitrary number, and makes the managing of transmitter, posting and other register books unnecessary. Retrieval of documents according to different aspects is feasible.

2. Archiving: CLEVERARCHI can store and manage scanned paper-based and electronic documents. Pictures of documents archived and data are easy to be retrieved and to be on view.

3. Workflow support: The software supports the execution of everyday work and multi-stage workflow effectively, and makes them easy to schedule and control. CLEVERARCHI delegates the tasks to the appropriate teams, does the deadline monitoring and warning of users, performs reports and does the fill-in of blank forms.

Subsequently the main user functions of CLEVERARCHI are: input of paper-based documents by scanning; fax and mail server in order to integrate internal and external flow of information (also able to register and archive incoming faxes and mails automatically); managing appendices (registry numbers, addresses, remarks, comments etc.); recognition and assignment of printed

characters, digits and bar-codes to the documents registered; grouping of documents; multi-aspect retrieval of documents, data export into different file formats; search (in scanned documents as well); picture viewer (picture of documents stored appears on the screen); reports, statistics in arbitrary structure (e.g. on the efficiency of a team etc.); deadline watching and warnings (CLEVERARCHI Message, e-mail or SMS); distribution and signing of documents; recording and tracking the storage location of documents archived. The software also offers DAC inistration functions, such as the customization of documents view, maintenance of users and the authority system; tuning of capacity and efficiency of the system, performance monitoring.
Besides software development and sale, the Company also provides peripheral hardware tools needed, such as scanners, bar-code readers, bar-code printers, and provides service connected. Special hardware tools the Company provides for its customers are:

1. CamScan: This equipment enables the input, restore and archiving of documents and data sheets (e.g. CVs, personal data sheets, identity cards etc.) in the computer, supplied with color photos as well. The equipment contains a black-and-white scanner (in order to read sheets), a color camera (in order to record photos/pictures) and an Optical Character Recognition device (which recognises printed characters). The technical oddity of this equipment is the parallel use of a black-and-white scanner and a color camera, which makes the functioning of CamScan faster and more economical than equipment using a color scanner.

2. Speedy Reader, Passport Reader: Speedy Reader is an optical data input tool, which records the postal cheque laid on the target disk and converts it into a data readable by computers. Passport Reader is a data input tool to be integrated into computer networks, which can take photos of and read data in personal documents of different types (passports, identity cards etc.), performs examination of authenticity and forwards collected data.

3. Gepard File Encryptor USB Key: This is a microcomputer running an encrypting algorithm, which enables an efficient protection of confidential data, encoding and decoding files, folders, folder structures.

DAC executes the installation, maintenance of hardware tools and training of users as well.
Further activity of the Company includes the software package Registauto, which does the storage, evaluation and transmission of data on sciatic prosthesis surgery, collected in accordance with standard medical aspects.
DAC also developed a polling system used in elections (e.g. ethnic autonomous elections in 1999, 2006).
DAC executes (1) system DAC inistration, (2) the operation, supervision and maintenance of central computer pool, (3) network management and (4) software development within the frameworks of an outsourcing activity as well.

Management/Employees

DAC has a total number of 19 core employees (including management). The Company has 13 additional employees, who provide outsourcing services for Telco2. More than 70% of employees are designing engineers or computer professionals.
The management team consists of five people, namely: Mr. Balázs Vezér, CEO; Mr. GS., Head of Sales and Marketing; Mr. T. V.; Head of Product Development; Mr. P. P., Head of Implementation; and Mr. B.G., Head of Support. Each member of management has a qualification in the field of technology and long-term experience on the planning and implementation of large systems. Majority of managers emerged from DAC's staff. Mr. Vezér plans no changes in management structure in the future.

Core markets and competition – Competitive landscape

Market trends

The market of so-called content and document management systems is to grow dynamically not only in Hungary, but in the EU as well. Founded on a survey on content and document management[6] in some European countries (UK, Benelux, France, Germany and Scandinavia) made by Rethink Research Associates, penetration in the developed Europe is still quite low. *An average penetration of 33%* was calculated from the survey, however, only Germany

[6] Enterprise content management consists of the following: (1) document management; (2) web content management; (3) digital asset management; (4) records management and (5) workgroup collaboration. DAC doesn't deal with web content management, so that the findings of the survey can be applied only restrained.

(37%) and France (29%) can take pride in around 30% penetration figures. Much lower share of the companies in the rest of the countries/regions examined have such systems in use (17% of Benelux and 7% of Scandinavians). Of the companies examined that currently have no content/document management system, 60% plan to invest in one in the coming two years, and 48% of the companies having content management system expect to extend their installations in the coming two years. The key factors behind their intention are the clarification of workflow and business processes, the management of digital assets (e.g. copyrighted works) and the compliance with legislation and regulation in the US and the eurozone.

Figures above point to the fact that (concerning development differences) the penetration of content management systems in *Hungary is surely deep under the lowest observed ratio of 7%*. The penetration on the target market of DAC is in addition lower, concerning that the systems examined by the survey cover a wider range (*see in footnote*). As a result, the potential for market growth is much larger in Hungary than in the developed Europe. Regarding the driving factors, EU regulation and legislation (besides the intention to keep firmer control of corporate performance and efficiency) is an important motivational factor in the examined countries.

In Hungary, a low level of function exploitation is a basic characteristic. The demand for expanding functions is mainly typical of large innovative companies. Small size enterprises are at an initial stage described by system establishment and network development, using mainly the e-mailing function. Medium size enterprises cannot be categorized, either large, or small enterprises' features can be applied for them, particularly depending on the number of sites and client base. However, according to Microsoft Hungary, medium size enterprises will be the main target in the next 5 to 10 years.

According to DAC's estimations, the *size of large enterprise market amounts to about 5000 companies*. SME sector covers a wider range of companies of over 20 000. The financial size of market is hard to be estimated because of the existence of orders without tendering, but after DAC's managers it can be set to HUF 1-1.5 billion a year.

Customers, partners

The target market of DAC is the large and medium size organizations segment. In this segment, projects are usually tendered to a select group of companies active in the document archiving and management field. According to DAC's

management, the Company is invited to the majority of the tenders written by large customers in Hungary, and has an over 50% win-rate. DAC as vendor of the document archiving/management technology participates on these tenders very often in consortium with major IT multinationals. Besides participating at tenders, sales are carried out through direct approach, or occasionally by participating on local trade shows.

Further opportunity for acquiring clients is provided by the integrator contract signed with Telco1 and planned to be signed with SAP and PRINTCO Rt. In the sense of the contract signed with Telco1 Rt., Telco1 and DAC cooperate to satisfy adequate needs of 3rd parties. (Essentially Telco1 recommends the products and services of DAC for its customers, according to DAC's management.) This contract has a maturity of one year (signed on 1st June 2007), and automatically elongates with one year unless abrogated. (*See in contractual review.*) The sense of the strategic partnerships planned with SAP and PRINTCO is the same.

The management also purposes to enter on the document archiving/management market of foreign countries in the future. The planned cooperation with PRINTCO would be a determining step in this direction because of PRINTCO's extended relations with actors of foreign markets (mainly in former socialist countries).

The importance of these contracts is to be detected in the decreasing costs of client acquiring as well. This kind of cooperation makes the pre-sales period much shorter, DAC has to latch on to client management only at the point of bidding. (Without integrator contract, pre-sales period can last from 2 months to 1.5 years, consisting of the addressing of marketing materials, visitation at reference clients etc.)

Main customers of DAC include major local companies and Hungarian subsidiaries of multinational firms. Major customers in 2006 were:

- Water Co.: revenue EUR 159 000; share 21%;
- Dutility: rev. EUR 87 000; share12%;
- Telco2: rev. EUR 80 000; share 11%;
- Chemco: rev. EUR 78 000; share 11%;
- Gasco: rev. EUR 51 000; share 7%;
- OILCO: rev. EUR 38 000; share 5%.

Other customers together (Metalco Kft., CarCo Hungária Kft., Bank1 Rt. etc.) had a 33% share of revenues in 2006.

The Company had 35 clients (small and big ones together) in 2006. According to the experiences so far, 60% of newly acquired small size clients and 100% of large ones remain in the customer base of DAC. Due to the great potential of increase in the Hungarian market, the Company plans to duplicate its client base until 2012. Managers of DAC plan their future acquirement of large clients based on the analysis of top 50 ranking of companies acting in Hungary. The number of companies in the top 50 working without document/workflow management systems is 17.
The *pipeline* of the company is promising, it shows that the company is contacting about 40-45 companies in a potential contractual value of HUF 600 million. However only HUF 26 million value of contracts has been signed out of the list on the date of the application.

Contract types
The contracts DAC signs with its customers can be divided into three main categories:

- one off delivery contracts, which result in a single payment for customizing, installing and delivering the products;
- support contract: general maturity of 1 year, payment depending on the client (monthly/quarterly/yearly in advance or posteriori);
- software update contract: yearly charge to be paid in advance, maturity generally 1 year.

Almost all large clients and nearly 50% of small clients require support service – small ones either in the form of indefinite maturity contracts or ad hoc engagement. Experiences so far show that active customers require support each year. The average price of support amounts to HUF 0.5 million yearly.
Upgrade is required by active clients who use their systems constantly, and in each year get their systems upgraded. The mean price of upgrade totals HUF 0,6 million/year.
Besides, DAC signed a contract on outsourcing activity with TELCO2. In pursuance of this contract, DAC provides service for TELCO2 on site. The main tasks are: input of subscriber contracts into Contract Management System and receptionist task performance. In order to perform these tasks, 13 employees of DAC are at TELCO2's service, remunerated after working hours accomplished.

Competitors

Actors on the Hungarian market can be either suppliers of 3rd party products, or suppliers of proprietary products. Experience shows that DAC successfully competes against both types of market players due to the functional features of its products, good customer references and easy adaptability of its product to the ERP systems used by its customers. The main competitors of DAC are:

- proprietary product suppliers: Montana, IBM, Graphton, Freesoft and Archico (also supplier of 3rd party products);
- 3rd party product suppliers: T-Systems, Hewlett Packard, IQ Soft and Synergon.

Contractual Review

- Integrator contract signed by DAC and Telco1 Rt. has a maturity of one year (signed on 1st June 2007), and automatically elongates with one year unless abrogated.
- Outsourcing contract with TELCO2 is signed without maturity. Abrogation time is asymmetric: in case of TELCO2's abrogation, it totals 3 months; in case of DAC abrogating the contract, abrogation period amounts to 6 months.
- Exemplars of delivery contracts, support contracts and software update contracts are available. Specific terms of each contract depend on the client.

Financing facilities required by DAC

- Long-term loan of HUF 128.8 million for financing acquisition of 80% of DAC.
- A credit line of HUF 10 million, in order to finance eventually appearing working capital needs, available for separate transactions, disbursed on the basis of individual decisions. Credit line is needed for the import procurement of hardware tools (the purchase price has to be settled in advance at the distributor abroad).
- DAC's guarantees at two commercial banks in an amount of nearly HUF 5 million will be taken over by CORPBANK with cash collateral.

Suggested Terms and Conditions

Long-term loan

Amount	HUF 128.8 million
Facility type / Maturity /	5 years
Denomination	HUF
Draw-down	Single draw-down.
Repayment	even repayment, quarterly
Coupon payment	Quarterly, actual/360
Base rate	3 months BUBOR
Margin	1.2 ≤ DSCR < 1.5 400 bp 1.5 ≤ DSCR < 2.5 350 bp 2.5 ≤ DSCR < 3.5 300 bp 3.5 ≤ DSCR < 4.5 250 bp 4.5 ≤ DSCR 200 bp
Up-front management fee	1%
Covenants	Negative pledge, Ownership clause, Pari passu, Cross default Fresh long-and short term borrowing with the consent of the Bank Senior debt (all other liabilities are subordinated) Quarterly financial report
Securities	Assignment of sales revenues Pledge over all fixed and floating assets, licenses, trademarks
Other conditions	Opportunity for pre-repayment

Credit line

Amount	HUF 10 million
Facility type / Maturity /	Revolving
Denomination	HUF
Coupon payment	Quarterly, actual/360
Base rate	Overnight BUBOR
Margin	1.2 ≤ DSCR ≤ 1.5 300 bp 1.5 ≤ DSCR < 2.5 250 bp 2.5 ≤ DSCR < 3.5 200 bp 3.5 ≤ DSCR 150 bp
Up-front management fee	1%,- flat
Commitment fee	1% p.a.

Guarantee limit

Amount	HUF 4.8 million
Facility type / Maturity /	Revolving
Denomination	HUF
Fee payment	Quarterly
Guarantee fee	2 %
Up-front management fee	-

Financial Evaluation

Historic performance

DAC's performance since 2004 has progressed remarkably – showing the widening of its activity and client base. The net income increased from a loss of HUF 2.27 million to a gain of over HUF 21 million. Gross margin amounted to nearly HUF 67 million in 2006, which gives 36% of net revenue (HUF 20 million in 2001 and HUF 48 million in 2002). EBITDA in 2006 totaled HUF 30 million. This year's figures show a flourishing operation: turnover in the first half of 2007 (totaling HUF 75 million) indicates a 12% increase related to the corresponding value in 2006, while EBITDA amounts to nearly HUF 20 million. These figures don't truly characterize the Company's performance, as – due to

the sector's features – major part of sales is always realized in the last quarter of the year.

The Company has total assets of HUF 106 million, a third of which consists of fixed assets (value HUF 35 million). The Company has inventories of a minimal value (HUF 2 million in 2006), which results from the immediate selling of assets purchased from a 3rd party. Inventories appearing in the balance sheet of DAC consist of marketing materials, the value of which increases parallel with net revenue. Customer claims are relatively high due to favorable payment conditions given to its customers.

DAC doesn't have any short- or long-term loan. Its liabilities comprise of prepayments from its customers (HUF 1 million in 2006), trade suppliers (HUF 43 million in 2006) and other short-term liabilities (HUF 8 million in 2006, including basically tax liabilities). Value of trade suppliers typically increases parallel with the rise in net revenue.

Projections – Client's case

- HUF 128.8 million (EUR 511 thousand) credit
- Maturity 5 years
- Interest rate: 11%
- Revenue increases significantly
- Constant ratio (of 2007) of material type expenditures/revenues
- Slight improvement in personal type expenditures/revenues despite enlarging manpower and wages increasing by 5%
- HUF 72 million total CAPEX until 2012 (a conservative projection of yearly CAPEX HUF 12 million, which is expectedly higher than the real need of the activity)
- Average income from support amounts to HUF 0.25 million/year/ active client, average revenues from upgrade total HUF 3 million/year/active client happens every 5 years in average (every 5th client)
- Average on-off revenue by new client acquisition is 16 million HUF

Conclusion

In the case of client's plans coming true, cumulated cash-flow calculated following debt service is strongly positive. The financing power of the transaction is especially demonstrated by considering that a conservative estimation of CAPEX is used for calculation (according to the management, a

CAPEX of nearly HUF 4 million is supportable from year 2008). Accomplishment of repayment and interest payment isn't endangered in client's case.

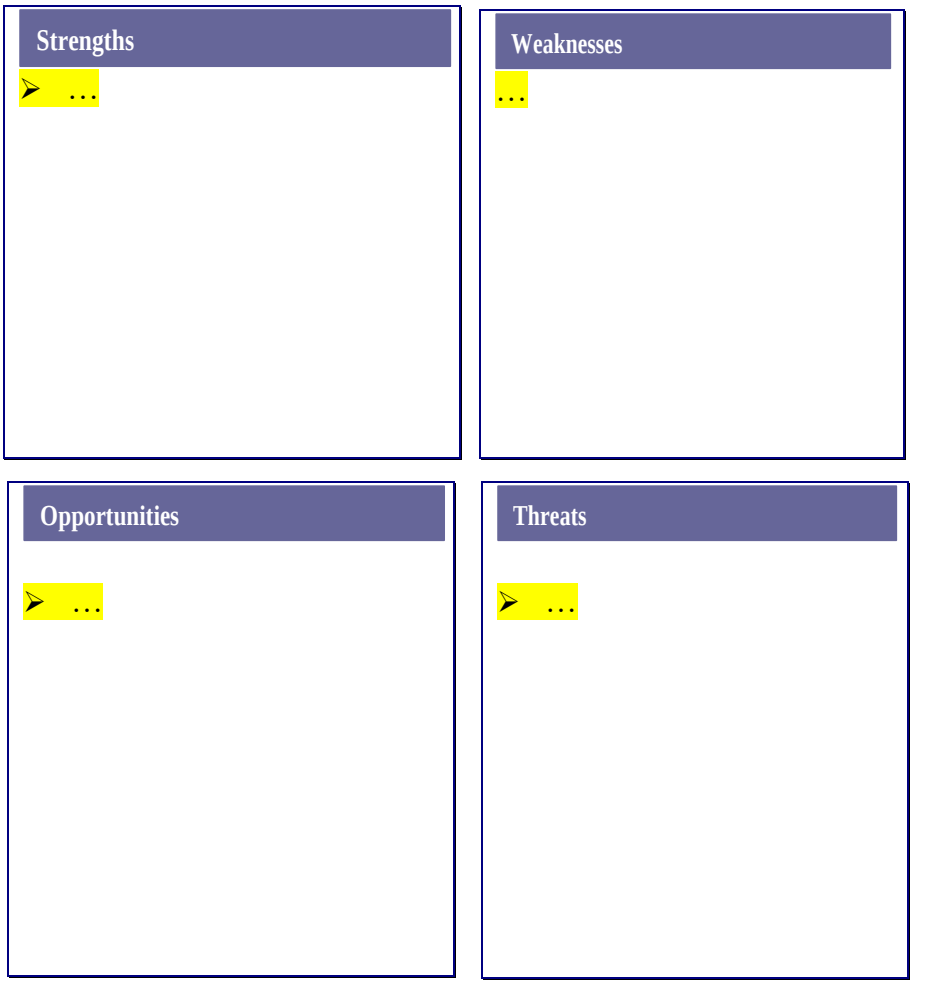
Projections – Break even

…

Projections – Conservative case

…

SWOT Analysis



ROE

The transaction offers to Corpbank an expected pre-tax ROE of 13.14% and a gross revenue of HUF 6.92 million for 2007.

Amendment

DAC's client base widened newly by acquiring TRASPORTCO. Negotiations are proceeding, and the contracts are expected to be signed in the near future. This deal offers a huge increase in DAC's revenues, so that the risk of financing the MBO becomes much lower. Service contracts to be signed ensure monthly revenues of at least HUF 25 million from 1st January 2008 (earliest maturity on 31st December 2013), so that TRASPORTCO may become the largest customer of the Company (HUF 25 million/month is the minimum amount that will be paid by TRASPORTCO, the maximum can reach HUF 37 million/month).
Besides, three other contracts are to be signed:

(1) a supplier contract on the hardware tools needed (in a value of HUF 97.4 million; margin around HUF 30 million);

(2) an auditing contract with a monthly revenue of HUF 3.57 million (the margin of which totals 100%; earliest maturity on 31st December 2010);

(3) a contract on consultancy until 31st December 2007 in a value of HUF 50 million (which will be performed through subcontractors).

In consequence of this deal, cash-flows streaming from DAC's operation change in the following way.

Conclusion

DAC is a significant actor on document archiving/management and workflow management market. Market penetration of document and workflow management systems in Hungary is fairly low, so that the Company's management forecasts further increase in revenues due to widening client base. ….

Summarised: The main risk of the deal …

Considering risk factors and profitability based and relied on available information, we ...

APPENDIX 1. Acquisition pipeline at DAC Kft. (reflecting latest information)

Client	Value eFt
Energyco2	60 000
Bank2	40 000
Energygroup	40 000
Gas3co	40 000
Retailco2	40 000
Cosntructionco	30 000
Transportco	30 000
Zenon	30 000
Airco	25 000
Beerco2	25 000
Energyco5	25 000
Beerco1	20 000
Gasc4co	20 000
Itco	20 000
Pow erco	20 000
Verticon	15 000
Chemco Rt	12 000
Dutility	**12 000**
Printco	11000
Oillco	10 000
Stateco, Debrecen	10 000
Waterco2	10 000
Retailco1	9 803
ÉVR	**8 000**
Constr2	7 761
Waterco3	**6 700**
BBB	5 000
Oilco	4 000
Client1	2 626
Retailco1	2 400
Carco1	2 000
Logictics	2 000

APPENDIX 2. A classification of DAC's activities

The main activities DAC performs in the field of office documentation and document management are:

- developing software for office automation; selling software CLEVERARCHI Digital Office:
  - CLEVERARCHI Digital Office Software enables the secure long-term storage of mailing and confidential data by storing large amount of paper-based and digital documents, the software enables to retrieve a file in seconds and to make workflow monitorable;
  - the functions CLEVERARCHI provides are: registry, archiving (paper-based and electronic documents and identifiers), workflow support (automatic allocation of tasks, deadline-watching and warnings);
  - CLEVERARCHI is an integrated client-server software able to be integrated into existing information systems, and to work together with mailing, groupwork and control systems;
  - CLEVERARCHI's main feature and its most important differentiating factor to competition are the easy integration of the software with SAP, Scala and other ERP systems;
- distributing software Registauto used for surgery database management;
- operation and distribution of polling systems;
- software related services:
  - (file handling) workflow assessment; development, integration and installation of workflow management systems;
  - training for users and system DACinistrators;
  - support: hot-line telephone support; on-the-site support; intervention;
  - updating;
- planning and installing specialized data input units and scanners;
- distributing, installing and maintaining peripheral hardware tools:
  - scanners, bar-code readers and printers, special hardware developments, CamScan (which enables to input, store and

archive documents, data sheets supplied with color photos), Speedy Reader M70+ (optical data input tool, which records the postal cheque laid on the target disk and converts it into a data readable by computers), Passport Reader;

- hardware related services:
  - installation, training, guarantee, warrantee, maintenance;
- special services related to handling of documents:
  - arrangement, rejection, shredding and rehousing of files, documents;
  - permanent management of filing-cabinets;
  - document storing and supplying of data;
  - internet-based services;
  - postal services;
  - selling and manufacturing wrappers for handling documents;
- business services:
  - operation of central computer pool;
  - network management;
  - software development;
  - outsourcing activity (special services): preparing regulation for file handling; filing-cabinet services; lease-scanning; data registering.

APPENDIX 3. Clients case and financials

avarege annual support revenue/client	250 THUF
average annual upgrade revenue/client	600 THUF
acquisiton one off revenue/ client	16 000 THUF
tax rate	16%

'000 HUF	Fact	Planned					
P&L Statement	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Net revenues	**188 476**	**…**	**…**	**…**	**…**	**…**	**…**
growth		…	…	…	…	…	…
Telco2 outsourcing revenues	31 054	32 640	34 272	35 986	37 785	39 674	41 658
One-off revenues (client acquisition)	125 000	…	…	…	…	…	…
Upgrade revenues	23 672	…	…	…	…	…	…
Support revenues	8 750	…	…	…	…	…	…
Material type expenditures	**118 390**	**…**	**…**	**…**	**…**	**…**	**…**
% of revenue	*63%*	*44%*	*44%*	*44%*	*44%*	*44%*	*44%*
Personal type expenditures	**31 428**	**…**	**…**	**…**	**…**	**…**	**…**
% of revenue	*17%*	*35%*	*28%*	*27%*	*26%*	*25%*	*25%*
Other revenues	0	0	0	0	0	0	0
Other expenses	8 522	6 284	7 115	8 398	9 164	10 491	11 042
Depreciation	6 967	7 691	8 983	9 888	10 522	10 965	11 276
EBITDA	**30 136**	**…**	**…**	**…**	**…**	**…**	**…**
Operational result	**23 169**	**…**	**…**	**…**	**…**	**…**	**…**
Net result of financial operation	561	0	0	0	0	0	0
Result of ordinary operation	**23 730**	**…**	**…**	**…**	**…**	**…**	**…**
Net extraordinary profit		0	0	0	0	0	0
Pre-tax profit	**23 730**	**…**	**…**	**…**	**…**	**…**	**…**
Income taxes	2 381	…	…	…	…	…	…
After-tax profit	**21 349**	**…**	**…**	**…**	**…**	**…**	**…**
Dividend							
Balance sheet profit	**21 349**	**…**	**…**	**…**	**…**	**…**	**…**

Cash-flow		**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
EBIT		…	…	…	…	…	…
Depreciation		7 691	8 983	9 888	10 522	10 965	11 276
Income tax		…	…	…	…	…	…
Gross Cash-flow		**…**	**…**	**…**	**…**	**…**	**…**
Change in Net Working Capital		-5 073	-6	-2 553	1 640	-1 538	4 575
Free Operational Cash-flow (before CAPEX, debt financing)		**…**	**…**	**…**	**…**	**…**	**…**
CAPEX		-12 000	-12 000	-12 000	-12 000	-12 000	-12 000
Free Cash-flow		**…**	**…**	**…**	**…**	**…**	**…**
Change in financial investments		13 850	500	0	0	0	0
Financial Cash-flow		**13 850**	**500**	**0**	**0**	**0**	**0**
Total Cash-flow		**…**	**…**	**…**	**…**	**…**	**…**
Total debt service		…	…	…	…	…	…
Cumulated Cash-flow (after debt service)		**…**	**…**	**…**	**…**	**…**	**…**
ADSCR		**…**	**…**	**…**	**…**	**…**	**…**

Number of active clients	**35**	**43**	**56**	**70**	**86**	**103**	**121**
Number of clients acquired	**7**	**8**	**13**	**14**	**16**	**17**	**18**

		3 months	12 months	13 months	14 months	15 months	9 months
Interest rate		11%	11%	11%	11%	11%	11%
total debt	128 800						
interest		…	…	…	…	…	…
repayment		…	…	…	…	…	…
remaining principle	128 800	…	…	…	…	…	…
credit line outstanding	10 000	10 000	10 000	10 000	10 000	10 000	10 000
Debt service		**…**	**…**	**…**	**…**	**…**	**…**
up front fee		…					

Blance sheet (MHUF)	**2006**	**2007**
Cash	3	4
Acc. Receivables	40	65
Inventories	2	2
Current assets	45	71
Fixed Assets	35	35
Assets	**80**	**106**

Acc. Payables	23	44
Otehr short term liab.	7	8
DEBT	0	0
Equity	50	55
Liabilities	**80**	**106**

Questions

Dominika read the credit application. Parts that must be completed or needed a decision were highlighted with yellow. She looked at the financial model (Appendix 3) that was also not completed yet, however included the basic structure. She did not have to do any cash-flow models herself nowadays but this time she decided to finish it alone. It was not difficult at all. First, she wanted to check the case of the client and its cash-flow. Based on that she wanted to "play" a little bit with the value drivers; she was curious, how the break-even and a conservative scenario look like.

She completed the application with these scenarios. She carefully looked and commented on the term sheet. SWOT analysis was also not completed. She hated SWOT, but this time she found it useful to understand the risk factors. So, she completed the SWOT as well. By the time she has finished her job, she had a firm opinion about the deal. She noted some sentences in the conclusion part of the application. (She did not consider the 10. point of „Amendment" yet as she wanted to discuss it with the relationship manager.)

She finished her work. She called her colleague who was responsible for the deal to discuss her findings and conclusions with him. She knew that they had a lot to discuss.

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5. DIFFERENT DRIVERS OF AN M&A TRANSACTION – BUYING WINE&DINE

Péter Juhász, PhD, CFA

Aim and theoretical background

This case aims not only at reviewing motivations for selling and buying firms but also to identify different types of possible synergies. The case offers an opportunity for modelling the bargaining process and understanding its link with the valuation performed earlier. A unique trait of the case is that it even illustrates the appearance of asynergies and requires students to address those.

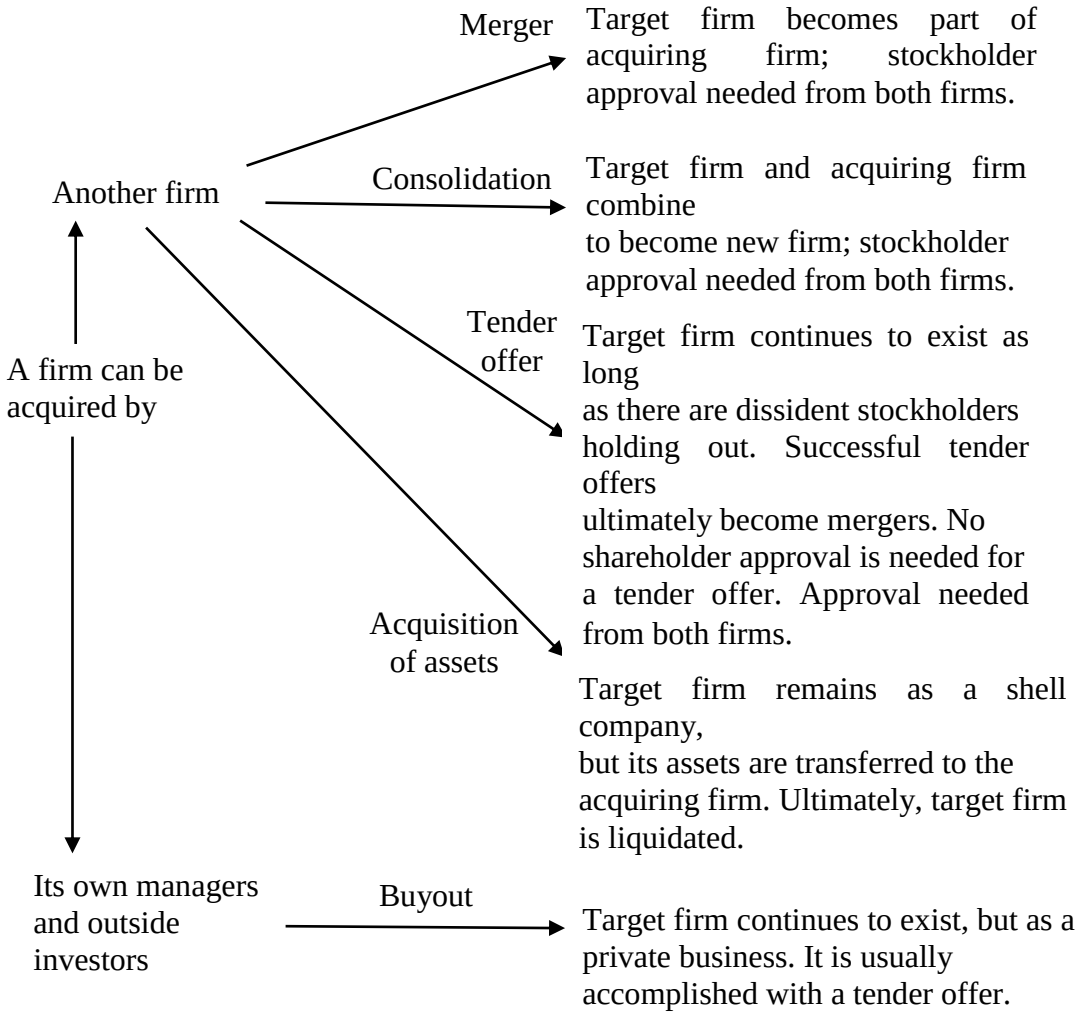
The words mergers and acquisition (M&As) may refer to several kinds of transactions. (Figure 1) If a company acquires another firm, we categorise the transaction further as (1) horizontal (buying a competitor from the same business), (2) vertical (purchasing a firm at a different stage of the supplier chain, e.g. your supplier or buyer) or (3) conglomerate merger (the activity of the other entity is unrelated to ours). (Brealey et al. 2011, pp. 792-793.)

We may find several reasons why the owners of a company would be willing to participate in an M&A transaction either as a buyer or a seller. Seller may need to liquidate some of their investments to start a new project, could need cash, may turn old, or be unable to overlook their inherited company. Divorce is also a classic motive for selling a private firm.

On the buyer side, the will to increase cash flow, decrease the risk of operation or need of invested capital is entirely in line with the shareholder value paradigm. However, it seems that there are many other reasons too. Based on an extensive literature review, Nguyen et al. (2012) state that besides the will of creating shareholder value, managers tend to support M&As to increase the organisation they lead for their interest (e.g. compensation, career, fame, hubris) or to make it more dependent on their own skills and knowledge. The term market timing refers to the practice where the management of an overvalued firm uses the shares of their company to pay for another firm that is less overvalued. By doing so, they try to take profit of the pricing anomaly and protect themselves against takeovers but may end up purchasing companies even at inflated prices. It is also common that several different motives act together as drivers for an M&A transaction.

Based on the shareholder value concept, only transactions that create value for both the seller and the buyer are economically justified. We may achieve this if both the acquisition premium (seller) and the value created for the acquirer are positive. These quantities are to calculate as follows.

Figure 1 Classification of acquisitions



Source: Damodaran, 2012, pp. 703.

Value Created for Seller = Acquisition Premium = Selling price – Value for Seller (1)

Value Created for Acquirer = Stand-Alone Value of Target for Buyer + Value of Performance Improvements in both Firms – Selling price (2)

To track down the amount of value created, we have to quantify the added value of the M&A, the so-called synergy that could be partly passed over to the seller by paying a premium. The synergy is quantified as shown next.

$$\text{Synergy} = \text{ValueforBuyer}_{\text{Together}} - \text{ValueforBuyer}_{\text{Acquiring firm}} - \text{ValueforBuyer}_{\text{Firm taken over}} \quad (3)$$

Note that synergy is the difference between the joint and the stand-alone values for the same owner. To realize some synergy, we need to have at least two companies.

Theoretically, an M&A could even pay off if synergy is zero or negative. (A negative synergy is called asynergy.) To understand this, we have to understand why one would pay more a firm than the current market value (or value for the seller in case of a non-listed company). We may list three reasons.

(1) The price for which the firm (equity) can be taken over is less than realistic. If the market is not efficient (shares are under-priced) or the seller is under some financial, regulatory, or other pressure, we may get a good deal.

(2) In case the buyer has better market connections, more advanced know-how, higher bargaining power, or some other competitive advantage, it is possible that by simply changing the way the company sold operated, the value of the target firm will rise.

(3) There could be positive effects that are to realize only if owning to specific companies. If a company purchases its supplier, they may not only cut back on operational risk but also optimize inventory levels and product development process. Should a firm purchase its competitor, its bargaining power both on the selling and buying side will increase, while they may save costs by centralizing some parallel activities. We call this effect synergy.

In the case of listed firms and liquid markets, synergies are the most likely motivators for a takeover as it is infrequent that we may earn profit from option (1) or (2). Undervaluation is usually present for a short period and current owners, unless not in need of money, tend to wait for better times instead of selling off their shares. Besides, these companies are far too transparent to allow poor management to act over a more extended period. However, in the case of

private firms, it is not rare to find majority owners under pressure due to financial need or health issues or lacking adequate knowledge to identify management shortfalls.

Although we know this, there is still a vast number of researches proving that most of the transactions create positive value for the sellers but a negative one for the buyers. (Koller et al. 2010, pp. 448-451.) This value destruction could be explained by the buyers being too optimistic about future improvements, both considering the total amount and time resource need of realization. Empirical research found that strong acquirers (above average profitability and growth), low premium payment, and being the sole bidder (no price war) increases the likelihood of creating value for the buyer.

We should not underestimate the importance of this method of shareholder value creation. It is not that firms just spent extra money not needed for their operation on these transactions; instead, in some cases, a key motivation for attracting new shareholder capital and organising IPOs is to finance M&As (Szabó and Szűcs, 2014).

As we may see, it is vital to predicting the value of future improvements (synergies) as precisely as possible. Damodaran (2012, pp. 707-708.) separates two main types of synergies. (I) Operating synergies include (1) economies of scale, (2) higher pricing power, (3) combination of different functional (e.g. marketing, manufacturing) strengths, and (4) higher growth in new or existing markets. (II) Financial synergy covers (5) access to excess cash to use if for financing good projects of the other company, (6) increased debt capacity, and (7) tax benefits.

We may also categorize synergies based on the way those influence the collective value of the firms. (Figure 2) Some synergies are (Type 1) added to the sum of the former values. When an office building is not needed anymore and could be sold, the income can be seen as a one-time effect. These items are the easiest to deal with during a valuation process.

Other synergic effects would (Type 2) create a value proportional to the joint value of the two firms. If productivity would improve thanks to the know-how acquired from the other firm, or cross-sales would boost income, the synergy is proportional to the value of the enhanced entity. These items may create a very different amount of value for different acquirers.

Figure 2 Value effects of different synergies

Merged firm without synergies	$V_{Before} = \frac{FCFF_{Before}}{(WACC_{Before} - g_{Before})}$
Merged firm with synergies	$V_{After} = \frac{(FCFF_{Before} + Synergy_{Type\ 2})}{(WACC_{Before} - Synergy_{Type\ 3}) - (g_{Before} + Synergy_{Type\ 3})} + Synergy_{Type\ 1}$

Finally, there are synergy elements (Type 3) the value effect of which depends on other factors or synergic effects. For example, if considering a growing-perpetuity-like operation, the value effect of a 1 percentage point of increase in long term growth due to the use of a brand name accessed through an M&A could be very different both in monetary and percentage terms depending on the long-term cost of capital that might again be affected by some increased debt capacity thanks to the transaction. Measuring the effect of these synergic elements could be extremely challenging in a real-life situation.

Due to these different effects, we can rarely separate the total synergy into addable elements. The sum of individual synergy effects is usually less than the total effect. So, a failure to realise some planned cost synergies may reduce the value effect of a growth synergy achieved even if that is in line with the predictions.

The purchase of Wine&Dine restaurant

It is December of 2019. The Hotel DreamWell is located near to the famous spa of Heviz, Hungary that heals and eases various types of musculoskeletal diseases. The hotel specialised itself on serving elderly arriving mainly from Germany, Austria and other western countries who provide a relatively high continuous booking rate. During the recent years, the number of these guests has slightly decreased as due to the improving living conditions, health care services and more health-conscious living style followed there are fewer people aged 50-60 who suffer from illnesses that the spa may cure. Many competitors compensated this by attracting more travellers from eastern countries, mainly

Russia. Instead of that, DreamWell increased its marketing spending in the EU15 countries to compensate for this trend. Under these conditions, preserving the excellent connection with travel organisers and guest returning each year become particularly important.

Just next to the hotel, a restaurant called Wine&Dine operates that offers not only traditional Hungarian food but also various healthy dishes to stay competitive. In the neighbourhood, there are various other places offering meals of various quality and price level. Still, due to the very similar pricing policies followed, the restaurant provides solid profitability. The firm expects a ROIC rate of 15 percent in 2020 along with a sales of 300 million HUF. Other details of their business plan are presented in Table 1.

Table 1. The current business plan of Wine&Dine

	2020	**2021**	**2022**	**Terminal value period**
Sales growth		6.00%	5.00%	4.00%
EBIT/Sales	21.00%	20.00%	20.00%	20.00%
Corporate tax rate	9.00%	9.00%	9.00%	9.00%
RONIC		14.50%	14.00%	14.00%
D/V	30.00%	30.00%	30.00%	30.00%
Operative cost of capital for the industry (r_A)	14.00%	14.00%	14.00%	14.00%
Cost of foreign capital (r_D)	5.00%	6.00%	6.00%	7.00%

At the end of 2019, János Kovács, the CEO of DreamWell comes to the idea that they could cut on costs if their guests would be served by the Dine&Wine. The main issue is that while guests require the hotels to offer some in-house dining opportunity but is very rare that they really would use this service. Instead, they prefer to walk in the town and try a different restaurant each evening. However, guests from other hotels never enter DreamWell for to get a meal. Thus, setting up or buying their restaurant that also receives guests from the street.

There could be various advantages gained from taking over Wine&Dine. Thanks to the better soundproofing, the firm could host various night events without disturbing the sleep of the hotel guests. In addition, buying the

restaurant would make the whole current kitchen area redundant. Most of the kitchen equipment (current book value: 5 million HUF) could be immediately sold for 10 million HUF. The kitchen area could be transformed into a wellness centre generating an FCFF of 4.2 million HUF at an annual growth rate of 4 percent. The setup would require an investment of 50 million HUF, the unleveraged cost of capital for the industry is 12 percent.

Currently, the hotel expects an FCFF of 120 million HUF for 2020. Thanks to the planned transformation, due to the better restaurant service and the hosting of more events, the top management expects that the predicted 3 percent growth may climb to 4 percent for there consecutive years (2020-2022) per year otherwise the perpetuity-like pattern of the operation remains unchanged.

The operative cost of capital for running a hotel is assumed to stay fixed at 14 percent, the leverage (D/V) stays at 35 percent, the current 10 percent corporate tax rate will be stable, while the required rate on foreign capital stagnates at 5 percent level. After 2022, the growth of FCFF will be 3 percent.

The CFO of DreamWell believes that thanks to his great connection with some local bank managers, the hotel could get a debt financing for Wine&Dine up to 35 percent of the total firm value. Due to the centralised marketing efforts, the current growth rate of the restaurant might be boosted to 8 percent for the next three years. (After that period, the growth would return to the currently expected 4 percent per year level.) During the same period, RONIC could be enhanced to 15 percent by taking profit of the great supplier connections of DreamWell.

Once approached by DreamWell, the owner-manager of Wine&Dine received the idea of the takeover cautiously. At the second meeting, he presented his plans on how to change the current operation of the restaurant. Recently the number of tourists with Slavic background boosted, he explains. These people are in their 40s, and their cultural background is quite different. Thus, they have a strong demand for going out, but the city has not too much to offer. After his plans, Wine&Dine should turn into a kind of night club that presents an erotic show two-three times per night after 10 p.m. on a small stage.

Based on his estimations, the transformation will cost 12 million HUF (spent and capitalized with a useful life of 8 years by the end of the year) and will raise the EBIT/Sales ratio to 21 percent without any further additional investments compared to the former plans. The growth rate after 2022 would remain at 5 percent.

The hotel management is scared. As this new image of Wine&Dine would be utterly inconsistent with the kind of guests DreamWell currently serves, the

FCFF of the hotel might fall by 10 percent immediately due to the shock (other value drivers remain unchanged). The board decides to act immediately to insure a smooth takeover at a fair price.
You are hired to help them as a consultant. Based on your prior experience the transaction costs (lawyers, consultants, due diligence, banking fee) for the seller could amount to 3 million HUF, while that of the buyer may reach 6 million HUF.

Questions

1. Identify the possible drivers for each party to take part in the planned M&A transaction.

2. What would be the lowest acceptable (reservation) price for the seller?

3. What would be the maximum price the buyer would be ready to pay?

4. What other aspects and information should the parties consider before entering the transaction?

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6. GLOBAL CAPITAL BUDGETING

Edina Berlinger

Aim and theoretical background

The aim of this case study is to confront students with the problem of capital budgeting in a multicurrency environment. Students are supposed to know basics of project valuation and the Capital Asset Pricing Model (CAPM). Now, the exercise is to apply these principles for an investor thinking globally and having investment opportunities in different countries.

If we have to decide whether a project is worth to invest or not, it is the net present value which is the safest tool. If NPV is positive, it is a good project, if it is negative, it is a bad project, Arnold (2010). (Internal rate of return IRR can give the same results if done correctly, however, it can be misleading in some situations.) If there are capital or capacity constraints, so it is impossible to realize all attractive projects right now, then it is the profitability value index (NPV/C_0) which helps ranking (Brealey and Myers, 2003, Jáki, 2004).

When calculating net present values (NPV), we define a basis currency called "home currency" which is the unit of accounting for the given investor. Cash-flows should be converted into the home currency with the help of spot or futures exchange rates. Basically, we have two approaches (Brealey and Myers, 2003):

a) First, we calculate the present value of foreign cash-flows with the help of foreign currency denominated expected returns, then convert the present value to the home currency with the help of the spot exchange rate.
b) First, we convert future foreign cash-flows to the home currency with the help of the corresponding expected future exchange rates, then calculate their present values using home currency denominated expected returns.

Doing correctly, the two approaches give the same result, but the second one may be processed easier. Expected future exchange rates can be calculated by the formula:

$$E(S_t) = S_0 \left(\frac{1 + r_t^{home}}{(1 + r_t^{foreign})(1 + crp)} \right)^t$$

where S_0 is the spot exchange rate (the price of one unit of foreign currency expressed in the home currency), $E(S_t)$ is the expected exchange rate for time *t*, r_t^{home} is the expected rate of return in home currency for time *t*, $r_t^{foreign}$ is its counterparty in foreign currency, and *crp* is the country risk premium of the foreign currency relative to the home currency.

Note that the uncovered interest rate parity does not hold necessarily, as some currencies are riskier than others from the investors' perspective, hence country risk premia are not always zero. Dömötör (2019) analyzed the fulfillment of the uncovered interest rate parity in the Hungarian market. In principle, we could hedge future cash-flows on the futures markets (i.e. convert them in advance at predetermined rates), however, the problem is that we have only estimations for the future cash-flows, but we cannot be sure of these quantities in advance.

Expected rates of return are usually estimated using the classical pricing formula of the CAPM:

$$r_i = r_f + \beta_i (r_m - r_f)$$

where r_i is the expected rate of return of the *i*-th project, r_f is the risk-free rate, β_i is the beta of the *i*-th project, and r_m is the expected rate of return of the market portfolio (Brealey and Myers, 2003, Bodie et al. 2011). (Of course, all these parameters can be different for different times *t*. For the assumptions behind the CAPM models see eg. Fazakas, 2018)

When implementing CAPM, the most important questions to answer are:

- What is the risk-free rate? As the investor calculates everything in the home currency, the risk-free rate is the corresponding treasury bill rate in the home currency.
- What is the market portfolio? As the investor thinks globally, the market portfolio should be represented by a global portfolio (e.g. MSCI global index), however, the expected return should be estimated by converting returns into the home currency first. The investor considers all returns in the home currency; therefore,

correlations should also be calculated between returns expressed in the home currency.

Note that using classical CAPM in this multiperiod and multicurrency context is not correct theoretically, firstly because CAPM is a one-period model, and secondly because CAPM assumes that all investors have the same basis currency and the same risk-free rate. The correct method would be to use a multiperiod version of the zero-beta CAPM (Black, 1972, Bodie et al. 2011) where the risk-free rate is replaced by the zero-beta pair of the market portfolio. In this case study, however, as most practitioners do, we set aside these problems and use the classical CAPM being aware of its limitations. Naffa (2009) shows empirically how asset pricing anomalies may occur.

Betas can be estimated (i) directly from the covariance matrix; (ii) indirectly from betas of the competitors (Brealey and Myers, 2003). Results are not necessarily the same but should be close to each other. In case (ii), we have to be careful with equity betas as they cannot be taken from the competitors due to the differences in financial leverages. In contrast, asset betas β_A can be taken over provided that the main characteristics (risks, growth, etc.) are the same. Asset betas can be calculated by weighting betas of equities β_E and debts β_D:

$$\beta_A = \frac{E}{V}\beta_E + \frac{D}{V}\beta_D$$

where *E*, *D*, and *V* are the market values of equities, debts, and the firm, respectively.

Case

A French investor considers investing into projects taking place in the US, in France, and in Hungary.

Cash-flows are presented in the following table:

	A (million USD)	**B (million EUR)**	**C (million HUF)**
0	-10000	-1000	-100000
1	3000	200	20000
2	3000	800	20000
3	3000	300	20000
4	3000	300	20000
5	3000	300	180000

Let us suppose that

- there are no taxes, no transactional costs, or legal restrictions to capital movements;
- betas of the projects and the risk premium of the market portfolio are stable in time,
- US offers 0%, Hungary offers 3% country risk premium to French investors.

Supplementary information

Spot FX rates (prices of one euro expressed in different currencies) are the following:

	EUR/USD	EUR/EUR	EUR/HUF
Exchange rate	1,11	1	320

The covariance matrix estimated from historical data (of course, from the French investor's point of view) is the following:

	A project	B project	C project	CAC40 index	S&P index	BUX index	Global index
A project	0,09	0,05	0,05	0,04	0,03	0,04	0,05
B project		0,64	0,14	0,10	0,08	0,11	0,16
C project			0,81	0,11	0,09	0,13	0,11
CAC40 index				0,36	0,06	0,08	0,04
S&P index					0,25	0,07	0,03
BUX index						0,49	0,04
Global index							0,09

Some data about competitors in the same industry are:

Competitors	A*	B*	C*
Equity beta	0,95	2	1,2
Debt beta	0,2	0	0
Leverage (D/A)	0,6	0,1	0

Risk-free spot yield curves in dollar, euro, and forint are:

	YC USD	YC EUR	YC HUF
1	1,6%	-0,5%	1,0%
2	1,5%	-0,6%	1,5%
3	1,5%	-0,8%	1,6%
4	1,6%	-0,9%	1,8%
5	1,8%	-0,8%	2,2%

Expected market risk premia of some indices coming from experts' estimations are:

	market risk premium over dollar risk-free rate (in dollar)	market risk premium over euro risk-free rate (in euro)	market risk premium over forint risk-free rate (in forint)
CAC40 index	12%	10%	10%
S&P index	9%	8%	7%
BUX index	10%	9%	11%
Global index	9%	8%	9%

Questions

1. Analyze the above projects from the French investor's perspective. Are these projects worth to invest or not?

2. What is the best choice if (i) projects are mutually exclusive and are the only available investments; (ii) projects are mutually exclusive (one of them needs to be done), but there is a wide range of other investments available; (iii) projects are not exclusive, but only 6500 euros are available to invest.

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7. MODELING LENDING IN CORPORATE FINANCE UNDER MORAL HAZARD

Péter Csóka

Aim and theoretical background

The aim of this case study is to illustrate some extensions of the basic model for lending in corporate finance under moral hazard. Tirole (2010) contains an excellent summary of papers and exercises related to the theory of corporate finance under asymmetric information. There is a lender and a borrower, and, of course, the borrower knows more about the project she is going to undertake. The unknown information could be the actions taken by the borrower (moral hazard) or the given properties of the project (adverse selection). The borrower has some initial assets at hand, but for the project to be undertaken, some extra outside financing is also needed. The question is how to specify the lending contract. The Nobel Memorial Prize in Economic Sciences was awarded to Jean Tirole "for his analysis of market power and regulation" in 2014, and in 2016 it was awarded jointly to Oliver Hart and Bengt Holmström "for their contributions to contract theory" (see Kóczy and Kiss, 2017). We assume that contracts can be forced without costs. In case of moral hazard, the efforts of the borrower cannot be verified (or are too costly to be verified), hence the contract can only be depending on the output. The moral hazard model is also called the principal-agent model, where in this application the principal is the lender, and the agent is the borrower. In case of adverse selection, the borrowers could have different, exogenously given types, where the lender only knows the distribution of the types and the realizations are revealed to the borrowers only.

In this case study we will consider some versions of the so-called fixed investment model (Tirole, 2010) under moral hazard, where the size of the project is given, the efforts of the borrower can be high or low (behave or not, where misbehaving gives some private benefit) and the project either succeeds or pays nothing. Even in the simplest version of the model interesting issues come up, hence we initially assume a risk-neutral lender and borrower, a perfectly competitive lending market and no time value for money. The so-called incentive compatibility and participation constraints of the borrower determine the parameters of the contract, that is how the income of the project

should be shared between the borrower and the lender in case of success. This way we also get an equilibrium implicit interest rate determined by the contract. Of course, it could also be that there is no feasible contract, in which case positive NPV projects are not undertaken. Relatedly, but maybe in a more general setting, many recent startups are trying to close the information gap and gain from completion of positive NPV projects which are not feasible without their help.

Various extensions of the basic model were considered even in Hungary. Csóka et al. (2015) adds the default risk of buyers to the model, where the borrower has some potentially not paying buyers. Berlinger et al. (2017) considers different versions of state subsidy in the model, which are further extended to renewable energy investments by Hortay (2019). Bihary and Kerényi (2019) model the gig economy with a dynamic principal-agent model. Kaliczka and Naffa (2010) explain the theoretical premise for manipulation-proof earnings categories that arise as a result of the agency problem.

In this exercise, we will check the following variants of the basic fixed investment model.

a) The lender could also be a monopolists, having all the bargaining power in specifying the contract.
b) We will check whether the set of feasible contracts can be extended by considering more independent projects at the same time
c) We will also consider what happens if after the investment but before the moral hazard problem the project could already fail, but the assets can be sold with some losses.
d) As a final twist, we will consider a version with an interim period where the borrower might need some extra liquidity for a very profitable project.

Case

Consider the fixed investment model with a risk-neutral lender and borrower, a perfectly competitive lending market, and with no time value for money. The parameters are the following.

I=100 (the required investment)
R=138 (the income of the project in case of success)
A=67.5 (the initial assets of the borrower)
$p_{H=}$0.75 (the probability of success if the borrower behaves)
$p_{L=}$0.45 (the probability of success, if the borrower does not behave)
B=27 (the private benefit of misbehaving).

Questions

1. Calculate the NPV of the project if the borrower behaves and also if he misbehaves, taking into account B!

2. How much is the expected maximal pledgeable income?

3. What is the lender's participation constraint? What does it mean? Does it hold in this example?

4. How much is the minimum value of the initial asset the borrower must own to receive financing?

5. What does "credit rationing" mean? Does it happen in this example?

6. Determine how the income of the project should be shared between the borrower and the lender in case of success, that is, set the values of R_l and R_b.

7. How much is the (ex-post) nominal interest rate in this example?

8. Give the values of R_l and R_b if the lender is a monopolist.

9. Assume that in the original situation (with perfect competition, etc.) the borrower has senior long-run debt, that is, in case of success, first 4 units have to be paid. The borrower cannot raise funds for the initial project without the consent of the holders of the senior long-run debt. What happens to the financing in this case?

10. Assume that in the original situation, the borrower has two identical independent projects and will only be paid in case both projects succeed. How much is the pledgeable income in this case? What is the participation constraint of the lenders?

11. How much is the chance of both projects being successful in the previous point? What happens if the projects correlate perfectly? Why is it better for the borrower to choose perfectly correlated projects?

12. Assume that in the original situation, after investing in the project, it will be viable with probability x=0.2 and we enter to the moral hazard problem. However, with probability 1-x=0.8 the project fails, and the assets are sold for P=80. How much is the pledgeable income in this case? Will the project be executed?

13. Assume that in the original situation, there is an interim period (after the investment) and the borrower has a new investment opportunity with probability λ =0.5. The borrower can get paid r_b in this interim period and invest it to get an income of $2*r_b$. This income is not pledgeable for the investors. Independently, the original investment will pay R=138 or zero. Let us consider contracts in which the borrower can be paid only in interim periods (r_b) or at the end of the project (R_b). How much is the optimal value of r_b and R_b?

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8. USING REAL OPTIONS FOR REAL ESTATES

Emilia Németh-Durkó – Dóra Gréta Petróczy

Aim and theoretical background

The purpose of this case study is to discuss and evaluate real estate investment opportunities from a real option perspective. We consider real estate development as an investment strategy offering many future scenarios. Growing uncertainty in the real estate market drives real estate management towards applying the concepts of real options. Initially, these real options are just plans and ideas, but they can also create value later in terms of growth, timing, and abandonment – as illustrated by our example. The following case study develops an option model that determines the optimal investment strategy regarding simultaneous or sequential housing development. It is based on Rocha et al. (2007).

Real options

A good starting point of the evaluation of real options can be a comparison with financial options. Financial options have been traded for centuries. Vanilla options are written on traded assets or securities such as a commodity, currency, stock or index (Lambrecht, 2017). Financial options are the focus of many textbooks, among others see (Keresztúri, 2019).

The term "real options", introduced by Myers (1977), refers to options embedded into investments such as the possibility of delaying, extending, converting, suspending, contracting or terminating an investment. The real options theory provides a methodology to evaluate an investment project in the presence of these managerial flexibilities (Rocha et al. 2007). Options theory is turned out to work in the housing market (Oh and Yoon, 2019).

There are many components which contribute to the success of real options valuation. First, it is the dynamics of the method. This multi-factor model measures value, probabilities, and interest, so one can create various scenarios (Lambrecht, 2017), while static models give only qualitative predictions that do not show dynamic relationships.

Second, these models can be tested on real data, which allows for the estimation of expected bankruptcy costs, issue costs, and managerial preferences. Thus, we do not neglect the ideal capital structure. Third, real option valuation motivates executives to think strategically and pro-actively. The method inspires managers to identify the opportunities at their disposal and to determine the criteria or conditions under which the strategy of the company can be successful. This pressure results in a proactive and adaptive leadership style in which decision-makers can remain flexible even in an uncertain economic environment. The method bridges the gap between rigid finances and flexible strategic planning (Lambrecht, 2017).

Despite the many benefits of the method, its complexity may explain why real option valuation is not (yet) so popular either in finance textbooks or in practice. According to a survey, university students and MBA course participants tend to rely instead on the static net present value (NPV) method, leaving option valuation to a later course. According to Graham and Harvey (2001) 75% of CFOs respond that they "always or almost always" use NPV, and only 25% claim to use real options methods.

Why invest in the real estate market?

The stock of houses under construction is usually substantial because of construction delays. It takes months or even years to build a new house. Not only the building of new homes but also the delays in the construction of incomplete ones can significantly influence the trends in residential real estate investments. However, applying a standard real-options model reduces uncertainty in future revenue due to good timing for the start of the construction works (Oh and Yoon, 2019).

The value of a company or the success of a project always include the values of the real assets and real options. Recently, the value of the know-how and exploitable opportunities have enormously increased at the expense of tangible assets. According to the Bank of America Merrill Lynch (Financial Times, 2016), compared to the financial assets, real assets have never been so undervalued before.

Figure 1: The value of real assets compared to the value of financial assets
Source: Financial Times, 2016

This shift in approach also means a new trend regarding the future performance of investment asset classes. Investors are interested as much in the exploitable opportunities arising from good future decisions as in the present value of the company. Analysts think that the shares of companies offering lower-category consumer goods might be on the winning side, while companies selling luxury goods might face difficult times (Portfolio.hu, 2016).

Real estate valuation through real options theory is different from the traditional approach and puts more emphasis on the aspects of flexibility and variability. So, when real estate is defined as a real option, it becomes the result of various choices made by the investor among several other options. This aspect completely changes the view of real estate (Lucius, 2001). Furthermore, "there are also several uncertainties related to demand, sale prices, land costs, unsold inventories, and regulatory and local government risks (licences, occupancy permits), which increase the investors' perceived risk" (Rocha et al., 2007, p. 2.).

Traditional investment theory treats property as a triangle of space, money and time, which generates cash flow for a specific period[7]. This perspective entails the relatively deterministic nature of the real estate, which means immobility and inflexibility (Lucius, 2001).

[7] For another case study for usage of a real estate with CF see Jáki (2017).

How to value real estates?

Immobility and inflexibility reduce uncertainty regarding the use of real estates. Therefore, the traditional methods based on net present value would be perfectly suitable to evaluate an investment. However, when significant uncertainty is involved in the sale of real estate for the investors, the traditional valuation methods become less suitable, as the investment opportunities might get undervalued, and the alternatives may be not reflected adequately. So, instead of using the traditional discounted cash-flow-based models, it might be worth considering real estates as real options. The option-based approach shows the flexibility and the strategic value of a project as well, thus the potential value of the future decisions would be included in the current value of the real estate.

One possible way to evaluate real options is to use the financial option pricing methodology. In this case, we need numerical inputs, which are the current value of the underlying product, the strike price, the risk-free interest rate, the duration, and the volatility (Fazakas, 2018). While in financial options they can be determined relatively simply, in real options it is often not immediately clear how to interpret them (Szűcs, 2015). Nevertheless, one of the basic assumptions of option pricing might cause problems, namely, whether the changes in the price of the underlying asset follow a geometric Brownian motion. Szűcs (2012) has proved that this assumption does not represent an unacceptable condition when applied to real options. Nonetheless, there is a broad literature on criticism of treating real options as financial options (Copeland and Tufano, 2004; Knudsen and Scandizzo, 2011; Lütolf-Caroll and Pirnes, 2009)

However, it might be questionable whether the options are applicable to real estates. Due to the high volume of investment, heterogeneity, limited substitutability, and relatively high transaction costs, real estate investments can be considered irreversible in the real options paradigm. Interpreting site and estate as a unit allows the construction of a duplication portfolio. Provided by the duration of the development process and the life-cycle of the investment, uncertainty and flexibility are guaranteed (Lucius, 2001). So, real estate investments can be regarded as real options. Consequently, the financial options approach can be applied to them.

Titman (1985) tries to explain why parking lots remain underdeveloped. The author handles the option to wait (sometimes called the timing option) as an American call without dividends and concludes that the option to wait can significantly increase the value of the land. The owner of a real estate project is

also able to discard the project. Williams (1991) confirms this opportunity results and expands the investigation by analyzing the effects of an option to abandon on the value of real estate developments. The author interprets this option as an American put without dividends.
It has been proved that in real estate valuation, the market price of the assets evaluated as real options are based on real option theory (Quigg, 1993; Cunningham, 2006; Bulan et al. 2009). Therefore, the conventional (financial) option theory can be applied to resolve our case study.

The case

You have recently received unpleasant news that your beloved aunt passed away at 95. The news surprised you because you never heard about an American aunt. The telegram was accompanied by an official letter inviting you to a probate hearing. You were almost sure that there was some misunderstanding, so you bought the plane ticket on the same day to travel to clear the situation as soon as possible. Instead of the much-awaited relatives, just one lawyer greeted you at the airport, with whom you drove straight to the trial. It turned out that Aunt Lydia had no living relatives besides you, and she left all her heritage to you. But what should you do with a hundred million US dollars?
Investing in real estate is prevalent today. However, is it worth it for you, too? You remembered your former best friend whom you studied together at Corvinus University in Budapest, Hungary. Peter always said that once he had much money, he would invest in real estate. Peter was the best in finance, today he owns an investment firm, so you contact him. The real estate market seems to be a good idea as you are not far away from this business. But you do not have adequate financial talent, so you give a lot to Peter's words. Peter shows you a figure (Figure 2) in a newspaper.

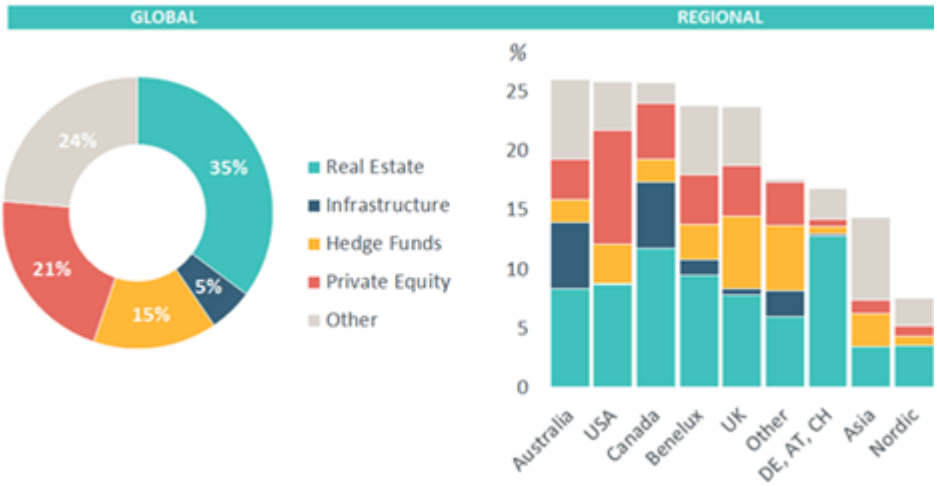

Figure 2: Alternative Allocations Across Regions
Source: MSCI (2015)

"The classic 60:40 mix of stocks and bonds has shifted to a 40:40:20 mix of stocks, bonds and alternatives, according to the 2014 MSCI Asset Owner survey. Real estate accounts, on average, for 35% of alternatives, or close to $700 billion of their total $10.3 trillion in assets under management, the survey found. The 138 asset owners held an average of 6.7% of total assets in real estate. However, if nine asset owners with no real estate are excluded, this figure jumps to 7.9%. Still, that average is understated as leverage expands the exposure, while many asset owners do not count REITs or CMBS within real estate" (MSCI, 2015).

You can see that the best decision is to invest in real estate – says Peter. After careful analysis, he offers you two alternatives. Consequently, you grab a pen and write down the following.

There is a two-phase residential housing project in the West Zone of Rio de Janeiro. In these developments, there is usually a difficult choice between simultaneous or sequential investment. The first option means that the construction of both buildings starts at the same time. In the second version, the developer waits for the first building to be completed and can start the second afterwards. The emphasis is on the timing.

The first strategy implies lower construction costs but more uncertainty as the demand and possible prices at the time of completion are unknown.

Sequential strategy comes with more information about the demand; however, the construction costs may become higher. The real estate developer has to pay

the administration cost twice, and the workers may also ask for higher wages. Instead of one large shipment of building material with a reduced price, the constructors have to order smaller cargos on full price.

Demand for newly built homes remains high, and housing prices in a big city are increasing at an unprecedented rate. There are many excellent universities here and a wide range of jobs, so a lot of young people are moving from the countryside and looking for apartments. They provide massive demand for the buildings. Moreover, this is good for us, because foreign investors pay for the flats immediately in cash. Thus, we can count on a solid return.

Therefore, given the conditions of supply and demand, for the sake of simplicity, we assume that after the construction we can sell the apartments immediately, and every buyer pays with cash. It is not possible to pay in instalments. You look worried as you have to consider which option to choose. You ask Peter to continue and finally expose the costs and risks since you do not have unlimited money.

The building of a phase takes 24 months (2 years). In the case of sequential strategy, if the first phase is successful, the second one can be built immediately. Furthermore:

- Both phases have an equivalent area of 20,736m^2, including a habitable area of 16,173 m^2;
- The selling price is USD 962 per square meter (for the habitable area);
- If the demand for houses is favorable, the selling price can increase 20% annually. On the other hand in the case of adverse market conditions, it can decrease by 5% per year. Both scenarios will occur with a 50% probability (meaning three possible outcomes at the end of the second year);
- The building cost is USD 308 per square meter for the first phase, and USD 338 per square meter for the second (prices in the year of sale and for the total area);
- Sales and other operational expenses are estimated to be 15% of the revenue;
- It is assumed that the whole building can be selledentirely to a foreign investor who will rent it to people moving to the metropolis.

Only one big question remains. How much would the land cost that the property is planned to be built on? Both of you are unsure about this, so you ask for the help of a third, old friend from the university, Eva, who lives in South America. According to Eva, the common practice in real estate is to pay for the land as a

percentage of the revenue, so the land cost is approximately 30% of the revenues.
You are already calculating, while your friends remain silent and browse the Internet. You do not understand why they do not want to calculate together with you. Your friends wonder how you can count. They think about how much you have learned since college. But it is just that you forgot to calculate with the cost of capital. Your friends smile and say: the cost of capital is 15% per year and the Brazilian risk-free interest rate is estimated to be 10% per year.
Solve the case together and discuss the following questions.

Questions

1. What kind of real options do you know? Give examples based on the case study. Are those American or European options?

2. What is the minimum selling price, which makes Phase I acceptable?

3. Calculate the expecting NPV of the sequential strategy.

4. Draw the decision tree of the project. Do you prefer the simultaneous or the sequential strategy?

According to some expert, the annual volatility of the selling price is in fact 20%.

5. What conditions do you need to handle this real option as a financial option?

6. In this case, do you prefer the simultaneous or the sequential strategy?

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9. REAL OPTION PRICING WITH MONTE-CARLO SIMULATION

Edina Berlinger – Krisztina Megyeri

Aim and theoretical background

Project or firm valuation is based on the idea of net present value, i.e. the discounted value of expected future cash-flows. This method is, however, too static (see also Jáki, 2004). It does not account for the possibility that managers intervene in the future: if conditions change, they can delay the project, they can increase or decrease its size, they can start new projects or liquidate the old ones, they can change technology, etc. These options are called „real options" and may add significant value to the project/firm.

Basically, there are two methods to value real options (Brealey and Myers, 2003). In both cases, we determine future scenarios and the corresponding cash-flows, then we calculate a present value. The difference is whether we use

- real-world expected returns and real-world probabilities (e.g. decision tree), or
- risk-free rates and risk-neutral probabilities (e.g. Black-Scholes formula).

If done correctly, the two methods give the same results. Method 2 (risk-neutral valuation) can be applied if the underlying asset of the real option (e.g. project value, cash-flows) is correlated to a traded asset. In this case, we can suppose that the real option can be replicated synthetically more or less perfectly, hence, the value of the project equals more or less the cost of the replication (Fazakas, 2018).

It is common to use risk-neutral valuation when we have to value a concession which gives the right to exploit a mine of a raw material traded on exchanges (e.g. gas or gold). In this case, the real option is a call option, the underlying asset is the raw material. Supposing that the price of the raw material follows a geometric Brownian motion (GBM), we can use the modified version of the Black-Scholes formula:

$$c = Se^{-yt}N(d_1) - PKN(d_2)$$

$$d_1 = \frac{ln\left(\frac{S}{K}\right) + \left(r - y + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

$$P = e^{-rT}$$

where *c* is the estimated value of the concession, *S* is the spot price of the raw material, *y* reflects the effects diminishing the value of the underlying asset expressed in yearly log return (e.g. due to exploitation of the reserve or to the delay in the realization of the project), *N* is the cumulative function of the standard normal distribution, *K* is the cost of exploitation, *r* is the risk-free rate expressed in yearly log return, σ is the volatility of the underlying asset (to be estimated from market data), and *T* is the maturity of the real option (Damodaran, 2005, Szűcs, 2015).

Note that Black-Scholes formula gives the price of a European-type call option under very strong assumptions (continuous trading with no transaction cost, known volatility etc. (Keresztúri, 2019)) while real options are rather American-type and there are many additional uncertainties (Szűcs, 2012). Therefore, the value given by the Black-Scholes formula can be considered as a lower bound of the real option's value.

This case study illustrates the difficulties of real option valuation even if the underlying asset is traded in liquid markets (crude oil). To solve the case study, students will need some further formulas.

The present value of an annuity with constant growth rate is

$$PV = \frac{C_1}{(r-g)}\left(1 - \left(\frac{1+g}{1+r}\right)^T\right)$$

where C_1 is the amount given at the end of the first year, *r* is the expected rate of return, g is the constant growth rate, and *T* is the maturity of the annuity.

In this case study, there is an additional factor of uncertainty: the exact quantity of the raw material which is not known at the beginning, just its distribution. To handle this, we can use a Monte Carlo simulation (detailed in Keresztúri and Illés, 2018). Quantity is supposed to follow a lognormal distribution with known parameters μ and σ. A stochastic variable X follows a lognormal distribution if

$$X = e^{\mu + \sigma Z}$$

where Z is a standard normal stochastic variable, and μ and σ are scaling parameters.
According to the Jensen inequality, if f is a convex function, then

$$f(E[X]) \leq E[f(X)]$$

As the value of an option is a convex function of the underlying asset (here, the value of the concession is a convex function of the quantity of the crude oil), we cannot simply work with the expected value of the crude oil reserve, because in line with the Jensen inequality, it would significantly underestimate the value of the concession.
Difficulties in real option valuation are related to the determination of the parameters properly (especially the volatility of the sources of uncertainty), to the selection of the right method of valuation, and last but not least, to the communication of the results (Fernandez, 2001). Valuation of real options is much less accurate than the valuation of financial options, it is more of an art than a science.

Case

A US mining company is thinking about buying a concession right to mine crude oil in an African country. The concession right can be bought in an auction (in dollar).
According to experts' estimation, the crude oil reserve in barrel follows a lognormal distribution with $\mu = 4$ és $\sigma = 0.3$. Exploratory drilling costs 5 million dollars at the beginning of the first year by which the exact size of the inventory will be known with certainty by the end of the year. If the company decides to develop the mine, then an additional investment of 600 million dollars is needed immediately. If the company buys the concession now, then it will have the right to develop the mine for 20 years (starting from the first year of development). The development lag is 2 years, and the maximal development capacity is 5 million barrels per year. The last year's profit should be spent on the reconstruction of the environment.
The price of the crude oil is 100$ per barrel, the development cost is 90$ per barrel. According to market experts, oil price is expected to grow by 2% per year, while the development cost is expected to decrease by 1% per year in the

long run. The cost of capital in mining is 12%, the risk-free rate is 2% (logreturn), and oil price volatility is 20%.
We can disregard taxes and transactional costs.

Questions

1. Simulate the size of the inventory and calculate the time of the development accordingly.

2. Determine the value of the real option for each simulated quantity with the help of the modified Black-Scholes formula.

3. Estimate the value of the concession as the average of the potential option values.

4. Calculate the expected value of the size of the inventory and calculate the option value accordingly. Why is it different from the result of the previous point (3)?

5. Discuss the assumptions behind the calculation.

6. Give advice to the company for the auction strategy.

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10. OPTIMAL CAPITAL STRUCTURE

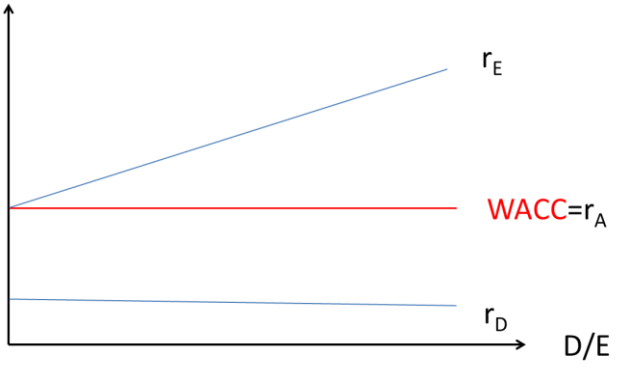
Edina Berlinger – Helena Naffa

Aim and theoretical background

Under the assumptions of Modigliani and Miller, investment and financing decisions are independent from one another. However, in the real world, these decisions cannot be separated. Firms' capital structure is a very important and well-researched area of corporate finance. There are several theories focusing on the tax advantage of borrowing and the costs of financial troubles (trade-off theory), on information asymmetries and transactional costs (pecking order theory), and even on some special issues like the protection of trade secrets or the costs of firing (Harris and Raviv, 1991; Brealey and Myers, 2003, Serfling, 2016, Klasa et al. 2018, Váradi, 2011). This case study focuses on the trade-off theory and help students to understand how to determine the optimal leverage in a realistic setting.

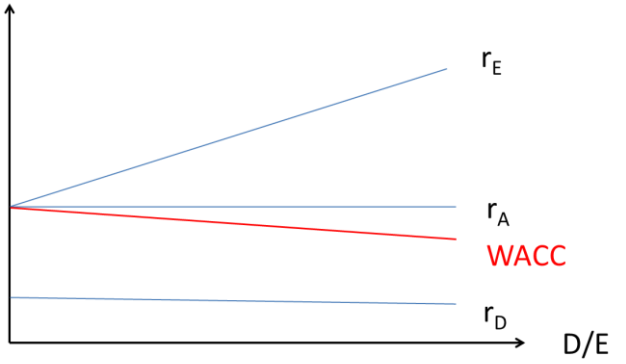
Projects can be evaluated by calculating their net present values (NPVs), i.e. discounting their expected future cash-flows with the weighted cost of the capital (WACC) (Arnold, 2010). In the Modigliani-Miller world, WACC is independent from leverage (debt-to-equity ratio) and equals the expected rate of return on the assets (r_A) (Brealey and Myers, 2003).

WACC in the MM-world



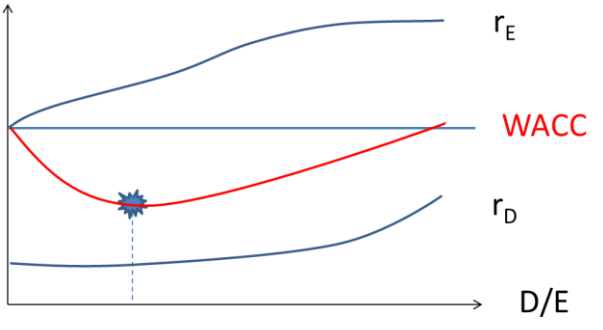
If we complement the Modigliani-Miller world with corporate tax, debt financing becomes attractive due to the presence of the tax shield, hence a higher level of leverage leads to lower WACC, thereby higher enterprise value.

WACC in the MM-world complemented with corporate tax



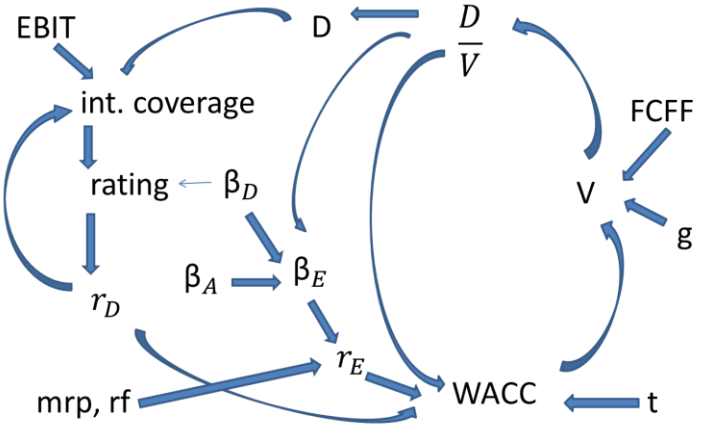
Realistically, it is not possible to increase the debt-to-equity ratio to infinity as there are other side effects of increasing indebtness. One of the drawbacks of high leverage is the increase of the cost of financial distress. Thus, the trade-off between tax advantages and financial distress means that finance professionals will be seeking an optimal level of leverage, where WACC is minimal and enterprise value is maximal.

WACC in the real world



In practice, the optimal leverage is difficult to determine due to the complicated interdependence structure between leverage, WACC, enterprise value, credit rating, etc. (Graham et al. 2015).

Interdependence structure



Due to the complex feedback effects, the optimal leverage can be determined only in an iterative way. This case study helps to understand interdependences, illustrates the trade-off theory of the capital structure, and introduce students to the practical difficulties in determining the optimal leverage.

Case

Black Iris Inc. is a company that currently has no debt. In 2019, its operating income (EBIT) is estimated to be EUR 1 million, its free cash flow EUR 900 thousand, the company has no significant asset depreciation and amortisation. A conservative estimate of long-term growth projects zero growth, the effective tax rate is 10%, unlevered beta is 0.9. Risk-free rate assumption is 2.5% flat for all maturities, market risk premium is 2%. Let's assume that the credit rating of the Black Iris is largely dependent on its ability to meet its debt repayment schedule. Therefore, the credit rating model suggests a certain rating for each level of interest coverage ratio. Interest coverage is calculated as EBIT/interest payment. Credit rating determines the cost of debt for the company. The table below specifies the credit rating and cost of debt for each level of interest cover. The loan covenants of Black Iris Inc. also specify certain levels of net debt/EBITDA ratios, if the covenants are breached, an additional distress premium is added to the cost of debt. The tables below detail the total cost of debt for the company.

Interest coverage (EBIT/interest payment)	Credit rating	Cost of debt
> 8.50	D	9,00%
6.50 - 8.50	C	8,00%
5.50 - 6.50	CC	7,00%
4.25 - 5.50	CCC	6,00%
3.00 - 4.25	B-	5,00%
2.50 - 3.00	B	4,30%
2.00 - 2.50	B+	4,00%
1.75 - 2.00	BB	3,75%
1.50 - 1.75	BBB	3,50%
1.25 - 1.50	A-	3,25%
0.80 - 1.25	A	3,00%
0.65 - 0.80	A+	2,80%
0.20 - 0.65	AA	2,50%
< 0.20	AAA	2,40%

Debt covenants - Net debt /EBITDA		
Min value	Max value	Distress premium
0	2	0,00%
2	2,5	0,00%
2,5	3	0,00%
3	4	0,50%
4	5	1,00%
5	10	2,00%

Determine the optimal capital structure for Black Iris Inc. and the associated WACC level, and enterprise value.

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Part II: Risk Management

11. MEASURING MARKET RISK OF EQUITY PORTFOLIOS

Barbara Dömötör

Aim and theoretical background

The aim of this study is to present the concept and methods of measuring market risk. Besides the theoretical background it provides an overview of the current regulation, the Basel framework.

In financial theory we differentiate *risk* from *uncertainty*[8], as in the case of risk we suppose, that although the future outcome is unknown, we know the probability distribution of it (Knight, 1921). So we are aware of the possible outcomes and the probability of each of them. To quantify risk, different *risk measures* can be used that characterize the distribution of the risk factor. While in investment theory risk is defined as the standard deviation (volatility) of the returns, and the analysis focuses on the risk-return trade-off, risk management considers the downside of the distribution (Walter and Kóbor, 2001, Csóka, 2003).

The *Value at Risk* (VaR) measure – that the current regulation is based on – is a given quantile of the distribution. It answers the question: how much is the maximum loss at a given probability (significance level) in the next, given period (time horizon) that we can suffer (Jorion, 2000). We usually add to the definition that "under normal market circumstances" that refers to the fact we do not count with structural changes or extreme market, although the model can be extended for "not normal" situations, like taking into account illiquidity as well (Gyarmati et al. 2011). The popularity of the VaR measure derives from the fact that it is easy to interpret and understand for non-financial decision makers, as well. Its disadvantage is that VaR gives no information about the worst outcomes. We just know that the loss will not exceed a given amount in the best 99% (significance level) of the cases, but we do not have any idea what can happen in the worst 1%.

[8] Heuristics along with increasing uncertainty are summarized by Jáki and Neulinger (2014).

There are some advantageous properties of risk measures that are summarized in the coherency axioms (Artzner et al. 1999) and that can be expected by a "well-behaving" measure of risk (Csóka et al. 2007, Bihary et al. 2018). Value at Risk does not always meet the condition of sub-additivity that requires that the risk of two separate portfolios is always at least as much as the risk of the merged portfolio (Hull, 2012).

Expected shortfall (ES) suggested by Acerbi and Tasche (2002) is an alternative risk measure that shows the expected loss in the worst given percentage of the outcomes. It has a very important theoretical advantage against the VaR, as it fulfils all the coherency requirements.

The three main risk categories that need to be offset by capital, are *market risk*, *credit risk* and *operational risk.*

This study introduces market risk, however credit risk is covered in the last chapter of this book. Operational risk management requires a little bit different considerations and more qualitative analysis (Berlinger et al. 2018), which is not scope of the present analysis.

Market risk is the risk of losses deriving from the changes of the financial market variables like interest rates, equity or commodity prices, or foreign exchange rates. Modelling the risk factor is the simplest in the case of market risk, as we have many data to be analyzed. To measure risk, first, we have to determine the distribution that has three classic ways: historical method, delta-normal method and structured Monte Carlo simulation.

The *historical method* provides that a given period of the past – reference period – perfectly represents the future: the outcomes (e.g. daily returns) of the past are the possible outcomes for the next day, either with the same probability (basic historical approach) or with exponentially decreasing probabilities (exponentially weighted historical approach).

Another way of describing the distribution is to provide that the returns stem from a given (most frequently normal) distribution and by knowing the parameters of the distribution the risk measure is to be calculated analytically. In the financial theory daily asset returns (logreturns) are considered as independent observations from the underlying distribution, based on this sample the parameters of the distribution can be determined.

Monte Carlo simulation is a numerical method that builds the distribution of the future outcome by generating random variables. The method has two approaches, either the stochastic process of the price evolution process is known

or the past observations are used to get the data from. Technical details of using the method can be found in Keresztúri and Illés (2018).

Regulation

The Basel Committee on Banking Supervision (BCBS) is the primary global standard setter for the prudential regulation of banks and provides a forum for regular cooperation on banking supervisory matters. Its 45 members comprise central banks and bank supervisors from 28 jurisdictions.
The latest standard, Basel III is a comprehensive set of reform measures, developed by the BCBS, to strengthen the regulation, supervision, and risk management of the banking sector. The measures include both liquidity and capital reforms. The standard was implemented in the European Union by the EU law *Capital Requirement Regulation* (CRR) (EU No 575/2013) that contains the rules of capital measurement and adequacy. Minimum capital requirements are set for 3 types of risks, market-, credit and operational risk, so that potential losses could be absorbed by the own funds of the financial institution, without threatening the solvency of the bank.

The regulation offers two methods for the banks to calculate capital, in the case of all three risk types. According to the standardized approach, banks have to follow the rules of the regulation that determines the calculation method and ratios of minimum capital need. Besides that, financial institutions are allowed to choose the usage of own models in calculating their risk and capital. The regulation is now under revision, target date of implementing the new rules is set to January 2022.
The *trading book* of a bank contains those assets that are bought for trading purposes and so exposed to market risk. Capital requirement in connection with market risk refer to the trading book's assets, except for foreign exchange risk that refers to the banking book as well.

Useful formulas

Effective return: $r_t = \frac{S_t}{S_{t-1}} - 1$

where S stands for price, and t stands for time.

Logreturn: $y_t = \ln(\frac{S_t}{S_{t-1}})$

Return of a portfolio: $r_p = \sum_{i=1}^{n} w_i \cdot r_i$

where w stands for weight, and i indicates a certain security

Variance of a portfolio: $\sigma^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} cov_{ij} \cdot w_i \cdot w_j,$

where cov_{ij} is the covariance between the returns of asset i and j

Please do not forget, the above two is valid for effective returns.

$(1-\alpha)$ quantile of $N(\mu, \sigma)$ $Q_{1-\alpha} = \mu + N^{-1}(1-\alpha) * \sigma$

where μ stands for expected value.

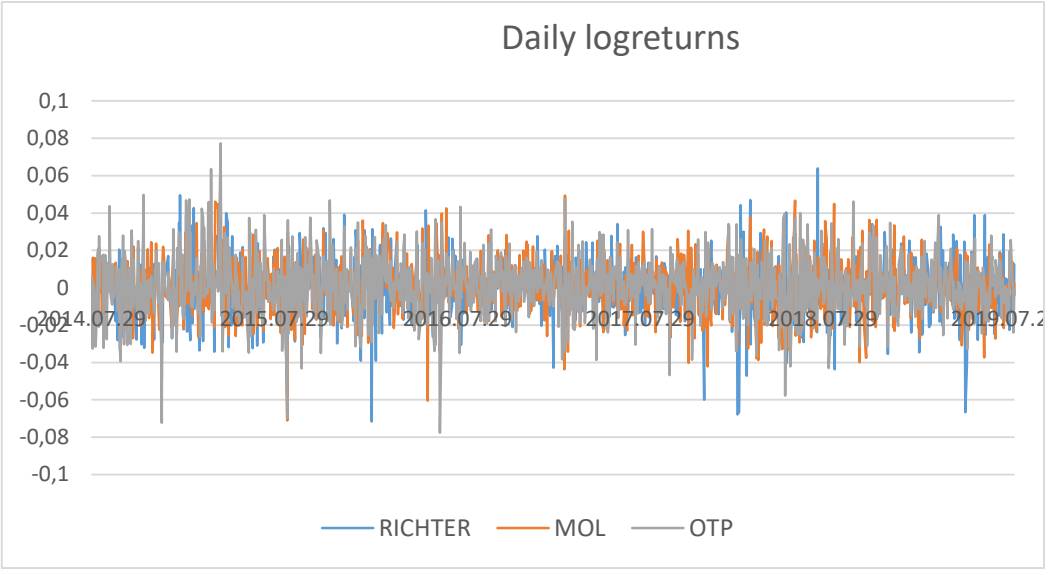
$(1-\alpha)$ ES of $N(\mu, \sigma)$ $ES_{1-\alpha} = \mu - \sigma \frac{e^{-N^{-1}(1-\alpha)^2/2}}{\sqrt{2\pi}(1-\alpha)}$

Case

The Bank has an investment portfolio consisting of 3 different stocks traded on the Budapest Stock Exchange: Richter, MOL and OTP, 1,000 stocks of each. The chart below shows the price movements in the last 5-years.

Source: Bloomberg

The Bank uses the standardized approach to calculate own funds requirement for the trading book's assets. As the assistant risk manager you are asked to check the market risk of the portfolio according to several risk measures.
The risk factor is the return of the stocks; the daily values are shown in the next figure.



As the standardized approach neglects the effect of diversification, you are considering whether the bank could benefit from the usage of an internal model.

Questions / exercises

1. Based on the last five years' data, describe the distribution of the daily logreturns for each stock!
    a. Can they be considered normal?
    b. Is there any sign of autocorrelation?
    c. Calculate and compare the annual expected return and volatility of the stocks!
    d. If the daily logreturns are normally distributed with the above parameters, what is the chance (probability) of a loss of more than 5% on the next day?
    e. What is the distribution of stock price if the logreturns are normally distributed?
    f. What is the reason of modelling returns instead of the price?

2. Let's consider the effective daily returns to be the risk factor! Calculate the 1-day Value at Risk and Expected Shortfall measures at 95% significance level for each single stocks according to historical simulation and the delta normal method! Interpret your results!

3. Calculate the 1-day Value at Risk and Expected Shortfall of the Bank's portfolio at 95% significance level, according to historical simulation and the delta normal method (by supposing the normality of the portfolio's effective return)!

4. Calculate the own funds requirements of the portfolio according to the standard method and the internal model based method!

5. Let's suppose the Bank uses delta normal method based on the last 250-days data to calculate the Value at Risk of the portfolio. Backtest the model on the data of the last 3 years!

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12. EXPECTED SHORTFALL: A CRITIQUE USING THE CAPM

Péter Csóka

Aim and theoretical background

The aim of this case study is to highlight one important critique of using Expected Shortfall as a measure of risk, based on the consumption based Capital Asset Pricing Model

The k%-Expected Shortfall (Acerbi and Tasche, 2002, see also Walter-Kóbor (2001) for downside risk measures in general) with $0<k\leq 100$ is the discounted average of the worst k percent of the losses. For $k=100$ it is the discounted average loss. The Expected Shortfall is often used to calculate capital requirements to cover possible future losses. As another application, Bihary et al. (2018) analyzes the Expected Shortfall of holding stocks in the long run. Acerbi and Szekely (2014, 2017) show that it can be estimated efficiently and it is also backtestable (they also show that elicitability is not equivalent to backtestability). Fain and Naffa (2019) show empirically how pure factor portfolios may be applied to test the validity of the efficient market hypothesis. Moreover, compared to Value-at-Risk, Expected Shortfall is a coherent measure of risk (Artzner et al. 1999), satisfying the axioms of subadditivity, monotonicity, positive homogeneity, and translation invariance. The current changes of the market risk regulation also aim to connect capital requirement to Expected Shortfall, instead of Value-at-Risk (Dömötör and Miskó, 2016). Note that discounting is usually omitted when using risk measures since for a few days it does not make any difference. However, as we will also see in the case, it is economically important to add discounting as it was in the original definition of coherent measures of risk.

The Capital Asset Pricing Model was originally developed by Sharpe (1964) and Lintner (1965). Under some rigorous assumptions, as it is well-known, the expected return of assets (and portfolios) can be related to their volatility (the variance of returns) using the Capital Market Line. Moreover, the expected return of assets can also be related to their beta (measuring the sensitivity of the asset returns to the returns of the market portfolio), using the Security Market

Line. Notions like diversification, alpha, and two-fund separation theorem are very standard both at the theoretical literature and in the industry.

Hens and Rieger (2016) summarize extensions of the basic CAPM model to heterogeneous beliefs and also present a behavioral CAPM. Moreover, they also show the derivation of a consumption based CAPM, where agents have stochastic wealth, optimize their utility of consumption by trading assets and markets clear, that is supply equals demand. On top of the standard CAPM, they also derive the Arbitrage Pricing Theory and a Behavioral CAPM as special cases.

The market in such a model can be complete or not. A market is said to be complete if all consumption streams (vectors) can be achieved by asset trade. Under complete markets (with some mild assumptions), it is standard to calculate state prices (or the prices of Arrow-Debreu securities), showing how much one unit payoff is worth of in each state.

Case

Consider a basic two-period model of an exchange economy with two time periods (t=0, t=1) and two states with equal probability of occurrence in period t=1. There is a representative agent having a von Neumann-Morgenstern utility function over its consumption (c_0, c_1, c_2) in the following form:

$U(c_0, c_1, c_2) = c_0 - \frac{1}{2}c_0^2 + \frac{1}{2}(c_1 - \frac{1}{2}c_1^2) + \frac{1}{2}(c_2 - \frac{1}{2}c_2^2)$.

Note that the (subjective) discount rate of the agent is 1.

The wealth (endowment, serving the market portfolio) of the agent depending on the state (including state 0 at t=0) is w=(0, 0.2, 0.5). The states, their probability of occurrence, the wealth of the representative agent, and the payoffs of five assets are given in Table 1.

s	p_s	w_s	A^1	A^2	A^3	A^4	A^5
1	0.5	0.2	1	1	0	-1	-2
2	0.5	0.5	1	0	1	-2	-1

Table 1: The states, their probability of occurrence, the wealth of the representative agent, and the payoffs of five assets.

Questions

1. An investor would like to hold some capital to cover the possible risk of assets 4 and 5 (A^4, A^5). Let the discount factor be 0.6. How much is the Expected shortfall for assets 4 and 5 at 10 %, that is, in the worst 10 % of the cases? How about 50 % or 100 %?

2. Are markets complete?

3. Calculate the equilibrium state prices and the equilibrium prices of the assets in Table 1!

4. Csóka et al. (2007) argue that the opposite of the asset price can be considered as a (general equilibrium) measure of risk. How risky are assets 4 and 5 in this sense?

5. Calculate the betas of assets 4 and 5 with respect to the wealth of the representative agent and check the Security Market Line of the CAPM formula (that is, calculate expected returns directly and also using the CAPM).

6. Compare the risk numbers you calculated using the Expected Shortfall and using the opposite of asset prices. Why are they different? Provide some economic intuition.

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13. MARKET LIQUIDITY – NEW ASSET ALLOCATION AT LIQWI LTD.

Kata Váradi

Aim and theoretical background

The aim of this case study is to calculate market liquidity on a simulated database, and also on a given order book. Liquidity has several meanings on the financial markets, which are summarized by Michaletzky (2010). The three main interpretations, categories of liquidity are the following:

1) liquidity of a company, meaning to be able to fulfill the cash-flow obligations when they are due;
2) liquidity of the financial system, meaning to have enough cash and cash equivalents in the financial system;
3) funding liquidity, meaning the contraints affect of corporate investment or hedging decisions (Dömötör, 2017).
4) market liquidity, meaning to be able to trade close to the actual spot price.

Since the focus of this case study is market liquidity, from now on under liquidity we will always mean market liquidity. The precise definition of market liquidity is given by BIS (1999, pp. 13.): "*Liquid markets are defined as markets where participants can rapidly execute large-volume transactions with little impact on prices*".

From this definition it can be seen, that liquidity has three important aspects: time, volume, and transaction cost. Since each of these three aspects are all important in handling liquidity issues during trading, or managing portfolios – risk allocation was analyzed in more details by Csóka (2017) and Csóka and Herings (2014) –, it would be important to have a single and simple indicator to measure liquidity. Unfortunately, there isn't such an indicator, since different indicators capture different aspects of liquidity. Csávás and Erhart (2005) and von Wyss (2005) collected several indicators that can be used to measure liquidity. These indicators can be grouped the following way: 1) indicators of transaction cost; 2) indicators of volume; and 3) indicators of price. Dömötör and Marossy (2010) analyzed the correlation of different aspects of liquidity and

define complex measures based on the single indicators. There exist several indicators in each group, but the research of Szűcs and Váradi (2014) showed, that the two most common indicators market participants are using in their everyday life are the bid-ask spread, and the turnover. They can be calculated the following way:

1) bid-ask spread: $Spread_t = P_t^{Ask} - P_t^{Bid}$, where P_t^{Ask}/P_t^{Bid} are the best available price levels on the market on the sell/buyside. The relative version of the bid-ask spread – which is very commonly used, and mainly when market participants talk about bid-ask spread, they mean the relative bid-ask spread – is the bid-ask spread divided by the midprice, which is simply the average of the best bid and ask price.
2) turnover: $v_t = \sum_{i=1}^{N} p_i^t \cdot q_i^t$, where *p* stands for the price, while *q* for the volume of *i*th trade at time *t*.

The bid-ask spread is easy to calculate if the market operates as an order driven market. This means, that the orders of the market participants are being collected in the so called limit order book (LOB). There are two basic types of orders on an order driven market, market orders, and limit orders. Market order means, that the transaction will be fulfilled whatever the market price is, so these orders will not be a part of the order book. Only the limit orders are being collected in the LOB, this means, that in case a market participant gives a limit order, a transaction will not happen immediately, only if the market price reaches the price given at the limit order. A trader gives an order like this, if he/she has time to make a transaction, and he/she thinks that the financial asset is under/overprice on the market, so not willing to receive/pay the actual price for the asset. If the trader has a time pressure, or the actual market price is adequate for him/her, a market order can be given instead of a limit order.

The build-up of an order book can be seen in Figure 1. On the left side, the buy/bid orders are being collected, having the best price – highest price - on the top, and the available size of transaction that can be fulfilled on that level. In the following rows of the order book, the prices are decreasing, which means that those who gave these orders are willing to buy only on a lower price. The right side is just the opposite. This side contains the sell/ask prices and volumes, but in this case the lowest price comes first, and the following prices are higher, meaning that it is worse from the market participants point of view.

This case study will be built on the limit order book, and on the liquidity measures, mentioned so far.

Case

Mr. Waters is working at the LiqWi Ltd. company as a fund manager. In the recent years, he was managing a fund, which contained only highly liquid assets. Now he decided to create a new fund, which contains 75% of illiquid emerging market stocks, while the remaining 25% is built up by liquid assets of developed market stocks. Mr. Waters found a stock, named Poco Aqua Ltd. in the Central-Eastern European region that he thinks would be a good choice to buy into the portfolio. He collected several information about the stock, and actually he is analyzing the liquidity of the stock. This morning he downloaded the order book of the stock in one certain second, which can be seen in Figure 1.

Order book			
Bidsize	**bidprice**	**askprice**	**Asksize**
5 000	660	662	4 000
2 000	659	664	6 000
3 000	657	665	3 000
2 800	654	668	2 000
1 200	653	669	2 500
4 000	651	670	4 700
2 000	650	671	1 200
1 500	649	672	5 000
2 000	645	680	3 000
5 000	640	682	2 500

1. Figure: Limit order book of Poco Aqua Ltd.

He wanted to carry out a detailed analyses of the liquidity of Poco Aqua, and decided to calculate liquidity not only by the bid-ask spread, and turnover, but some more complicated measures. He found, that the so called liquidity measures, like the Xetra Liquidity Measure (Gomber and Schweikert, 2002), or Budapest Liquidity Measure (BLM) (Kutas and Végh, 2005, Gyarmati et al. 2010) could be calculated as well, and also price impact measures. Liquidity Measures (LM) are weighted spread measures, meaning that they take into account not only the best price level, as the bid-ask spread, but the worse price

levels as well, during the calculation of liquidity. The calculation was the following:

$$LM = bidask\ spread + APM_{Ask} + APM_{Bid}$$

where APM stands for adverse price movement, which is calculated the following way:

$$APM_{Ask} = \frac{weigthed\ average\ price\ on\ the\ ask\ side - best\ ask\ price}{mid\ price}$$

$$APM_{Bid} = \frac{best\ bid\ price - weigthed\ average\ price\ on\ the\ bid\ side}{mid\ price}$$

For measuring price impacts, he used the Virtual Price Impact Functions (vPIF). Price impact functions show how the price changes as a consequence of trading, in the function of transaction volume. While "virtual" means that the PIF-s are calculated based on the limit order book, not on actual, fulfilled transactions. Virtual PIFs are calculated in three different ways: 1) marginal price impact functions (mPIF) (Bouchaud et al. 2008, Bouchaud 2010, Gabaix et al. 2003, Csóka and Hevér, 2018); 2) average price impact functions (aPIF); and 3) simple price impact functions (sPIF) (Váradi et al. 2012). Virtual means, the calculation are the following for each of the price impact functions, Mr. Waters was using:

$$mPIF = \frac{last\ price\ level\ during\ a\ transaction}{mid\ price\ just\ before\ the\ transaction} - 1$$

$$aPIF = \frac{average\ price\ during\ a\ transaction}{mid\ price\ just\ before\ the\ transaction} - 1$$

$$sPIF = \frac{mid\ price\ just\ after\ the\ transaction}{mid\ price\ just\ before\ the\ transaction} - 1$$

Mr. Waters believes, that by analyzing Poco Aqua Ltd. with these measures as well, he will get a better picture of the market liquidity of the asset.

Questions

1. Based on the order book Mr. Waters has downloaded, calculate the bid-ask spread, LM, mPIF, aPIF, and sPIF on different order sizes: 1 Million GFR, 5 Million GFR, 10 Million GFR, 50 Million GFR. (GFR stands for the currency in which Mr. Waters has his portfolio.)

2. Analyze the results you got in the previous question from liquidity point of view!

3. Simulate on order book that has similar liquidity characteristics to Poco Aqua Ltd! For help it is useful to read the article of Havran et al. (2012).

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14. ASIAXCHANGE CCP – INITIAL MARGIN CALCULATION FOR CENTRAL COUNTERPARTIES

Kata Váradi

Aim and theoretical background

The aim of this case study is to show how initial margin can be calculated according to the European Market Infrastructure Regulation, the so called EMIR. The EMIR was adopted in the European Union on 4th July, 2012 (EMIR, 2012) and it was supplemented by a Technical Standard on 19 December, 2012 (RTS, 2013). The main goal of EMIR was to set common rules for over-the-counter derivatives, central counterparties and trade repositories. In this case study we will focus only on central counterparties, especially on their risk management procedures, with the focus on initial margin calculation. The role of the central counterparties (CCPs) is to take over counterparty risk during trading with securities. This means, that on markets, where a CCP is operating, it becomes the buyer to every seller, and seller to every buyer, however there exists also decentralized clearing (Csóka and Herings, 2018) as well, but we will disregard it in our case study now. Naffa and Kaliczka (2011) suggest a new model via a publicly supervised central clearing to help alleviate the problems of non-paying loans.

The CCP guarantees the fulfillment of the orders in case one of the parties default, and cannot fulfill its obligation (Berlinger et al. 2016). In order to ensure the adequate financial resources to be able to cover losses of the defaulting member, the CCPs have to operate a multi-level guarantee system. This guarantee system is called default waterfall. The three most important elements of the default waterfall are: initial margin, default fund, and the skin-in-the-game (Murphy, 2017). The difference between the three layers is, that the initial margin can cover the loss only caused by the defaulting member (Berlinger et al. 2018, 2019), while the default fund is a mutualized layer, meaning that the non-defaulting members' contribution can also be used by the CCP. Finally, the skin-in-the-game is a certain part of the CCP's own capital. The order of usage of these guarantees is regulated by EMIR, in Article 45 and by RTS in Chapter IX, accordingly:

1. initial margin;

2. defaulting member's default fund contribution;
3. junior tranche of the skin-in-the-game;
4. non-defaulting member's default fund contribution;
5. senior tranche of the skin-in-the-game.

The optimal value of each level in the default waterfall is always an important question in practice also in absolute term, and also relative to each other. This problem has been analyzed in the literature, eg. Cont (2015), Glasserman and Wu (2017), Platt et al. (2017). There are several sometimes contradicting goals that should be taken into account when a CCP decides about the value of the margin, the default fund, or the skin-in-the-game, e.g. meeting regulatory requirements; increasing stress resistance level of the guarantee system; decreasing the cost of clearing members (so minimizing the value of the guarantees they have to pay, making the services of a CCP more attractive) in order to have competitive advantage compared to other CCPs.
This case study is dealing only with the initial margin calculation, which is regulated by EMIR and the RTS in the following parts: EMIR (2012) Article 41 – Margin requirements; RTS (2013) Chapter VI - MARGIN. When solving the case it is necessary to read these parts of EMIR and RTS, otherwise the case cannot be solved.

Case

The AsiaXchange CCP is operating in the Asian region, and is planning to extend its activity to the European markets. In order to achieve this goal, it is necessary to receive the EMIR license. The Risk Management Department (RMD) of AsiaXchange CCP got the task to analyze and modify the risk management models to fulfill the requirements of the EMIR regulation. The employees of RMD split the task, and Annie Li got the initial margin model revision. Annie Li is working at AsiaXchange CCP for 4 years now, and her main job was so far to calculate initial margin for every stock, that is cleared through AsiaXchange CCP. She has built her own model in 2017, which had the following characteristics, assumptions:

- She used the delta normal Value-at-Risk (VaR) calculation method (Jorion, 2007), with the following parameters:
    - significance level: 99%
    - look-back period: 250 trading days

    - liquidation period 2 days
- The margin was changed always on the first trading day of each month (this means, that the new margin was applied on the second trading day of each month), except if the daily logreturn of a security exceeded more than +/-10% on a daily basis during the month. In this case the margin has been recalculated, and changed for the following trading day.
- She used a back test as well for testing the VaR model she applied. She used the back test every time, when she changed the value of the margin. When she found during an initial margin recalculation, that the result of the back test was below 99% (which means, that the price change exceeded the initial margin more than 1% of the cases in the last 250 trading days), she applied a 10% buffer within the margin, so she multiplied the result of the VaR calculation with (1+10%). But if she found that the result of the back test was within 99%-100%, she disregarded the buffer (if there was any).

When she read through to adequate part of the regulation, she found that the most important missing point in her method was, that it does not take into account procyclicality. There were some other insufficiencies as well, but as a first step she wanted to handle procyclicality properly. She found, that the following three methods can be used according to RTS 28.1:

a) *'Applying a margin buffer at least equal to 25% of the calculated margins which it allows to be temporarily exhausted in periods, where calculated margin requirements are rising significantly (RTS, Article 28.1a, 2013)'*
b) *'Assigning at least 25% weight to stressed observations in the lookback period calculated in accordance with Article 26 (RTS, Article 28.1b, 2013).'*
c) *'Ensuring that its margin requirements are not lower than those that would be calculated using volatility estimated over a 10 year historical lookback period (RTS, Article 28.1c, 2013).'*

Before deciding which method to choose, she wanted to analyze all the three methods. Besides calculating the initial margin with all the method, she also calculated the Anti-procyclicality (APC) measures, recommended by the European Securities and Markets Authority (ESMA) in 2018 in a report and also by Murphy et al. (2014), namely the standard deviation of the log margin

change, and the peak-to-through ratio, which means the ratio of the highest and lowest margin value in the least 250 trading days.

Questions

1. Download the EMIR and the RTS to be able to answer the questions, and read the Article 41 in EMIR and Chapter VI in RTS, which regulates initial margin calculation!

2. Define initial margin for a freely chosen Asian stock with the method created by Annie Li!

3. Calculate the initial margin for the same security with all the three methods!
   a. Create assumption for all of the three methods, where it is needed to be able to calculate the initial margin. If you need help, the following sources can be useful: Béli and Váradi (2016), Berlinger et al (2016, 2018), Ladoniczki and Váradi (2018), Murphy et al. (2014, 2016).
   b. Plot figures on the time series of the calculated initial margins!

4. What aspect should be taken into account when we would like to decide which method to use? Point out the advantages and disadvantages of each of the three methods!

5. Show how the three different initial margin method take into account procyclicality based on the APC measures of ESMA (2018) and Murphy et al. (2014)!

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15. MANAGING RISKS AND GETTING UNDER THE CENTRAL COUNTERPARTY'S SKIN

Melinda Szodorai

Aim and theoretical background

This case study aims to show the composition of the default waterfall of a central counterparty (from now on: CCP) in order to understand the importance of the sensitivity of its structure.

A CCP's leading role and purpose are to centralize counterparty risk management in the financial markets that operate (Pirrong, 2011). The main idea of CCPs is that trading through a CCP, a bilateral trade between two counterparties is replaced by two symmetric trades between the CCP and each counterparty (Berlinger et al. 2016, 2018). Cont et al. (2010), Iyer and Peydró (2011) point out an essential function and benefit of these market infrastructures, namely the prevention of adverse effects and spillover of a defaulting counterparty. Compared to bilateral trading, where the default of one entity can spread throughout the system leading to a chain of contagious defaults, by multilateral netting among market participants there is higher transparency, risk-sharing among members of the clearinghouse is achieved (Csóka and Herings, 2018). Also, there is no need of duplicative monitoring, and mitigation of counterparty risk is managed through the CCP as members of the system are insulated from each other's default, reducing frictions in commitments (Nosal, 2011, Platt et. al. 2017). Naffa and Kaliczka (2011) describe a new model to operate under a regulated and transparent market to address the problem of defaulted loans.

Central counterparties do mitigate counterparty risk and are prepared to withstand under "extreme but plausible market conditions." However, CCPs are no panacea, as if distress hits the financial system, CCPs are not an exception of harsh aftermath. While CCPs provide protection against idiosyncratic counterparty risk and serve as safeguards for the system as a whole, they offer no essential protection against aggregate risk and may even encourage risk-shifting (Biais et al. 2012). To avoid procyclical effects, the regulator requires CCPs to apply an anticyclical margining, consequences of which is analyzed by Berlinger et. al (2018, 2019). Another risk arises in current circumstances,

namely the default of the CCP itself. The default of a CCP, however, becomes a systemic risk, triggering the collapse, or at least weakening the resilience of an industry or economy. Duffie (2015) claims that in the case of this event, financial stability would have dramatic effects. These situations are not impossible. Since 1973 there were three events of this type and some near fail situations as well (Kiff, 2014). There are further concerns regarding the systematic importance pointed out by Markose et al. (2012). Learning from the global financial crisis the too-big-to-fail problem may cause headaches for everyone; CCPs also have a similar issue, the *too-interconnected-to-fail* (Berlinger et al., 2016). This is similar to the other phenomena tightly related to the moral hazard problem, meaning in the case of distress if CCPs would fail, the adverse effects would be so wide-ranging that they could become prime candidates to expect bailouts.

Regulators require CCP to operate a so-called default waterfall. A general default waterfall consists of three main components: margins, default fund contributions, and the CCP's own dedicated resources. Regulations require using the available balances in a preordered sequence:

1. In case of a default, the first resource to be used are the margins to cover losses of the defaulting members, but not the margins provided by surviving members. The value of the margins shall be procyclical (Ladoniczki and Váradi, 2018, and Szanyi et al. 2018)
2. The second available financial resource is the contribution of members to the mutualized fund of resources, the so-called default fund. The primary goal of the default fund is that as members contribute to it, there is loss-mutualization among them.
3. The third layer, if the previous resources are not enough to cover losses, is the amount of the CCP's own resources contributed to will be exhausted. This is called the skin-in-the-game. It shall be higher by 25% of the CCP's required capital[9].

The three components can be divided in more tranches, so in case of a default the exhaustion of the available resources can be: initial margin of defaulting member → default fund contribution of defaulting member → dedicated own

[9] In line with EU legislation (EMIR, 2012) A CCP's required capital shall at all times be sufficient to ensure an orderly winding-down or restructuring of the activities over an appropriate time span and an adequate protection of the CCP against credit, counterparty, market, operational, legal and business risks.

resources of CCP → default fund contribution of non-defaulting member → other financial resources of the CCP.
The methodology proposed by regulators aims to enforce the resilience of the financial system by increasing transparency and market infrastructures that are prepared to withstand extreme market events.

Case[10]

Charles Thomson focused intently on not letting his voice tremble as he ended the call with another clearing member leaving the CCP. He opens the windows of his office in Athens, Greece. Immediately he is hit by the vibrating sound of the cars. He took a deep breath and tried to think. He has spent his whole professional life working as a CEO of the Greek CCP.
Last year a speculative position of a clearing member blew a hole in the buffers that shook the entire energy market. A trader had some risky positions in the previous years as well, but luckily, it never ended with a loss. Currently, he built up some speculative positions that the spread between the Greek and Estonian power would open. Due to the stormy weather, the spread went right to the opposite, and it narrowed. Although the CCP managed to handle the situation by closing the massive amount of positions, the event had put its mark on the mood of the market. Moreover, additional capital needed to be injected. Shareholders showed their concern about the CCP's future.

About the CCP

The CCP is a state-owned market infrastructure. Charles Thomson was the CEO since it was established. They are a successful CCP all over Europe, being an active and permanent member on foreign markets. It's market presence grew in the last few years, resulting in a robust increase in financial terms and also achieved a much-diversified client portfolio, providing services for clearing members from all over Europe. This year's strategy is to continue the expansion. In order to achieve this, the focus is on the acquisition of new customers, the launch of new products, and the clearing of new markets. Thus, these are all opportunities to increase volumes and to reach better economies of scale. Organic expansion, maintaining a good relationship with the existing markets and customers, and secure operation is the main strengths. The capital increase

[10] The case is pure fiction. Any resemblance with reality is just coincidence.

was not part of the strategy, but it gave confidence in the CCP for market participants, and business growth was achieved easier.
Since the market distress created by the defaulted speculative positions, the CCP had to make some changes, especially in the pricing of the clearing service.

Changes in clearing

The default fund was a little part of the default waterfall system, and it was composed mostly of the members' margin and the CCP's skin-in-the-game. Charles experienced that this model fraught with moral hazard because clearing members, having small real financial risk associated with the CCP, had little incentive to monitor the quality of the CCP's risk management or observe the conduct of other clearing members in the marketplace. In the latter event, closing the positions fell mostly upon the CCP. The skin-in-the-game amount was quite high, but the fee structure adequate compared to the current industry norms. It did not discourage members from taking excessive risks. The margining model did not fail; the CCP demonstrated its confidence in its margining models in the previous timeframe, but current events proved that a highly concentrated default position, where the clearing member cannot meet the margin call, exposes the CCP to excess risk.
Change in the default waterfall system was inevitable. The default fund contribution was increased significantly. Taking the volume of the positions into account, the default contribution for every member was increased, and everyone was obligated to contribute on a pro-rata basis. The margining methodology remains unchanged, but regulators require that stress shall be included in the calculation methodology; therefore, current events increased the payments for participants.
Low prices were the primary reason clients chose this CCP. Because prices are converging towards West European CCPs' prices, clearing members decide to change.
Current year's financial numbers are showing massive drops in revenues. Shareholders ask Charles to rethink the company's strategy in order to stop the decrease of the client portfolio, but the CCP shall maintain a resilient position on the market.

Questions

1. The CCP is a state-owned company. How does this fact affect the incentives of market participants? What could the management do in order to handle this? Would another increase in the capital be beneficial?

2. Why do you think clearing members abandon the CCP if prices are not higher than the international ones?

3. If you were an appointed consultant specialized in risk management, what options or alternatives would you suggest for Charles to resolve the CCP's situation?

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16. CREDIT RISK MEASURING

Barbara Dömötör

Aim and theoretical background

Credit risk is the most important risk type financial institutions are facing, and it is responsible for the majority of their capital need. The aim of this study is to present the main terms and calculations that the recent regulation applies in connection with credit risk.

Credit risk is defined as the risk of potential losses deriving from non-payment (*default*) or the change in the *credit rating* of a borrower, bond issuer or counterparty in a derivative transaction (Hull, 2015). The creditworthiness is described by the credit rating that reflects the non-performance probability of a borrower. Naffa and Kaliczka (2011) describe a new model for public role in tackling the issue of defaulted loans. Csóka and Herings (2019) model the possible losses using cooperative game theory. About measuring credit risk and the ratings at commercial banks see Walter (2014) about detailed analysis of parameters and evaluation of credit risk in the case of project financing see Walter (2019).

The *expected loss* on a credit depends on three factors:

- the *probability of default* (*PD*): the probability that the borrower goes bankrupt during the lifetime of the loan or bond. PD refers always to a given period, most frequently for the next one year. Being a probability, PD can take any values between zero and one.
- the *loss given default* (*LGD*): the proportion of the exposure that will be lost (not recovered) in case of default. Expressed in percentage. *Recovery rate (RR)* is the complementary of LGD: $LGD = 1 - RR$
- the *exposure at default* (*EAD*): the exposure expressed in absolute value (USD, EUR, etc)

To model the loss distribution all above parameters should be estimated. Exposure is easy to calculate for standard loans, but its value depends on market variables as well, in the case of derivatives contracts. Loss can be mitigated if the debt is secured by collateral, or guarantee, or netting arrangements apply.

There are three different concepts for estimation default probabilities:

1. Credit ratings as mentioned above, are reflecting the creditworthiness of the borrower. The three major credit rating agencies are Fitch, Moody's and Standard&Poor's. Credit institutions usually use their own models to estimate *PD* based on financial ratios such as debt to equity ratio.
2. Credit spread based method assumes that the lower value of an asset exposed to credit risk compared to similar, but credit risk free asset, equals to the present value of the expected credit loss. *PD* can be estimated using the credit spread or CDS spreads.
3. Structured models like Merton model consider the securities of a given company as claims on the company's assets. Using derivative's pricing we can calculate the expected default frequency.

Credit loss on a portfolio depends on the *PD* of the individual loans, but on the default correlations as well. Providing the non-performance depends on a common (macro) factor and individual factor that is uncorrelated with the common and other individual factors, the *worst case default ratio* (*WCDR*) follows Vasicek distribution (Mikolasek, 2018):

$$WCRD(T,X) = N\left(\frac{N^{-1}(PD)+\sqrt{\rho}N^{-1}(X)}{\sqrt{1-\rho}}\right) \quad (1)$$

T denotes the time horizon; *X* is the confidence level; ρ is the correlation coefficient. *WCDR* is the default rate that will not exceeded at a probability of X%. A credit portfolio consisting of loans with the same size and default probability has a value at risk as follow:

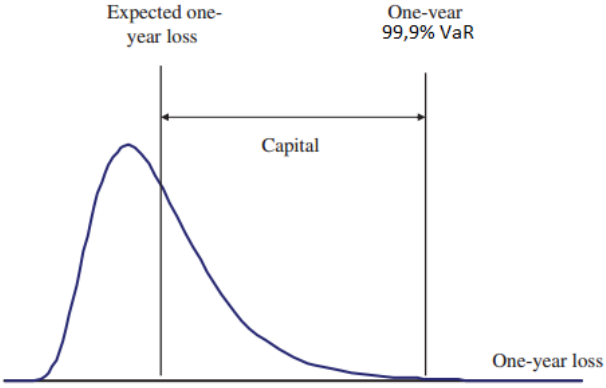
$$VaR(T,X) = L * LGD * WCDR(T,X) \quad (2)$$

L stands for the loan principal.
Gordy (2003) proved that if the portfolio is large and the size of the loans are small in relation to the size of the total portfolio, the value at risk is the sum of the individual *VaR* values:

$$VaR(T,X) = \sum_{i=1}^{M} L_i * LGD_i * WCDR_i(T,X) \quad (3)$$

Here *LGD*, *L* and *PD* refer to the *i*-th loan.

The regulation requires that the equity should be appropriate to absorb a potential loss with a high probability, so the capital need corresponds to a high confidence level (99.9%) value at risk with a one-year time horizon. In the case of credit risk, financial institutions are prepared for the expected value of credit loss by their pricing or profit reduction, so capital requirement refers to the difference of the *VaR* and the expected loss, the so called *unexpected loss.*



Regulation

Capital requirement for credit risk is also regulated in EU No 575/2013 Regulation (CRR). CRR offers, similarly to market risk, two approaches to determine own funds need for credit risk: the standardized approach and Internal Ratings Based (IRB) approach. The capital requirement equals to 8 percent (this is the famous Cook ratio) of the risk weighted exposure. The two above approaches differ in the determination of the risk weighted exposure. In the case of the standardized approach all exposures shall be assigned to one of the given (16) exposure classes, and the risk weights depend on the exposure class and the credit quality of the exposure. Risk weights range from 0 to 150%. Risk weights (*RW*) are allowed to be adjusted for collaterals.

Internal ratings based method can be used upon approval of the appropriate authorities. The risk weighted exposure is determined by the given weighting function that has the following form.

For corporate, sovereign and bank exposures:

$$RW = LGD * (WCRD - PD) * MA * 12.5 * 1{,}06 \qquad (4)$$

WCRD shall be calculated as shown above. The calculation of the correlation coefficient (ρ) and the maturity adjustment (*MA*) are to be calculated as follows.

$$\rho = 0.12 * x + 0.24 * (1 - x) \quad (5)$$

$$x = \frac{1-e^{-50*PD}}{1-e^{-50}} \quad (6)$$

$$MA = \frac{1+(M-2.5)*b}{1-1.5*b} \quad (7)$$

$$b = [0.11852 - 0.05478 * \ln(PD)]^2 \quad (8)$$

Parameter *M* denotes the maturity of the exposure.
We can see that the correlation coefficient is between 0.12 and 0.24, and decreases, goes to its lower bound, if *PD* increases. The argument behind is that if the default probability increases, default becomes more idiosyncratic and less dependent by the common, market factor.
As *PD* refers to one-year, maturity adjustment serves for quantifying the loss on a longer asset, deriving from the change in riskiness (*PD*).
The risk weighted asset (*RWA*) that is to be multiplied by the Cook ratio to get capital requirement is:

$$RWA = RW * EAD \quad (9)$$

IRB approach includes two methods:

- Foundation IRB Approach: in this case *PD* is calculated by the financial institution, but *LGD*, *EAD*, *M* are determined by the regulation.
- Advanced IRB allows financial institutions to use own calculations for all parameters.

Risk weight for retail exposure is to be calculated similarly, with the difference that there is no maturity adjustment and the correlation coefficient is set between 0.03 and 0.16.

$$RW = LGD * (WCRD - PD) * 12.5 * 1{,}06 \quad (10)$$

$$\rho = 0.03 * x + 0.16 * (1 - x) \quad (11)$$

$$x = \frac{1-e^{-35*PD}}{1-e^{-35}} \quad (12)$$

For residential mortgages ρ is set the 0.15 and for qualifying revolving exposures to 0.04.
For retail exposures all banks are using their own estimates for *PD*, *LGD* and *EAD* (Hull, 2015).

Case

The Bank has the following credit portfolio:

a) 5-year loan of 100 million USD to European Bank for Reconstruction and Development;
b) 500 million HUF unsecured loan to MOL Nyrt. with a maturity of 10 years;
c) 250 million HUF loan to Richter Nyrt. secured by immovable mortgage of 150 million HUF;
d) 200 million HUF loan to a medium sized, BBB rated company with a state guarantee for 90% of the exposure;
e) 3-years loan of 70 million HUF to a small enterprise secured by mortgage of 30 million HUF;
f) Personal loan commitment of 2 million HUF;

The credit ratings and Bloomberg's default risk calculations for the two exchange traded companies (MOL and Richter) can be found below.

Source: Bloomberg

Source: Bloomberg

Questions / exercises

1. Explain the main differences of the Standardized and Internal Ratings Based methods in calculation of capital requirements!

2. Draw a chart showing the worst case default ratio at 99.9% confidence level in the function of PD and ρ, based on a one factor Gaussian copula model!

3. Calculate the own funds requirement of the Banks's credit portfolio according to the standardized approach of EU No. 575/2013 Regulation (Capital requirement for credit risk, Chapter 2)! Describe the assumptions and concepts underlying the determination of risk weighted assets and risk mitigation techniques and the Credit Conversion Factors, if applicable.

4. Calculate the own funds requirement of the credit portfolio according to the foundation IRB approach! Use your own estimates, if necessary!

5. Suppose that a 3-year zero-coupon Treasury bond with a face value of 100 yields 5% and a similar 3-year zero-coupon bond issued by a corporation yields 5.5%. (Both rates are effective rates.) Make the simplifying assumption that there are no recoveries in the event of a default. Determine the probability of default! Determine the probability of default in the function of various recovery rates!

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