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Price formation of consumer loans: A theoretical view of Finnish consumer credit market

Economics

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Abstract

The purpose of this study is to present an economic theory behind the informational asymmetry in a consumer credit market and show how it affects the formation of the loan price. The study presents how lenders can use the available information for better loan decisions and how it affects the interest rates that borrowers observe. The main tools against information asymmetry are the information sharing platforms and the credit scoring models which are presented closely. The theoretical framework follows the model of Jaffee and Russell (1976) which is modified further to fit the different information levels that lenders can acquire about borrowers. Based on this theoretical framework the study presents the Finnish consumer credit market and discusses of the impact that the informational asymmetry has on the detected prices and on the market structure.

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1 Introduction

In this study I present the market setting for consumer loans that carry no collateral. I concentrate on the problems that asymmetric information creates on the loan market. The uncertainty of future payments and defaults is very real threat that lenders face. A borrower usually has more information on his financial standing and future plans than a lender can gather. This creates a risk for the lender that has to be taken into account in the pricing of the loan contracts. On the other hand if the price is too high it might attract only the borrowers with a high default risk.

Lenders possess different tools for evaluation of the default risk and they can get advantage on the market by being able to detect the default risk of the borrower. Information brings power and is an asset in a loan negotiation and pricing. If a lender can identify the risk of individual borrower, he can evade from the market price and extract extra profit.

The Finnish loan market has seen a rapid and fast growth of a small consumer loan business. It is typical for this market that the loan rates are very high, pricing is complex and the loan sums are relatively small. At the same time larger loan sums are carrying more reasonable prices. I study the basic dynamics of the loan markets by Jaffee & Russell –model (1976) and analyze how the Finnish consumer credit market fit in this framework. I also extend the model to take into account different levels of information that lenders possess and are able to utilize in credit decisions.

The study method is a literature review with an empirical part of market analysis about Finnish consumer loan market. In the Introduction chapter I am making the reader familiar with some basic concepts of loan markets such as time value of money and asymmetric information. In the second chapter I present the theoretical model of Jaffee and Russell (1976) that analyses loan markets with suitable characteristics for uncollateralized loan markets. In the third chapter I show how recent literature supports the pricing scheme of the model. The fourth chapter is about the ways a lender can identify default risk that information asymmetry creates. The main

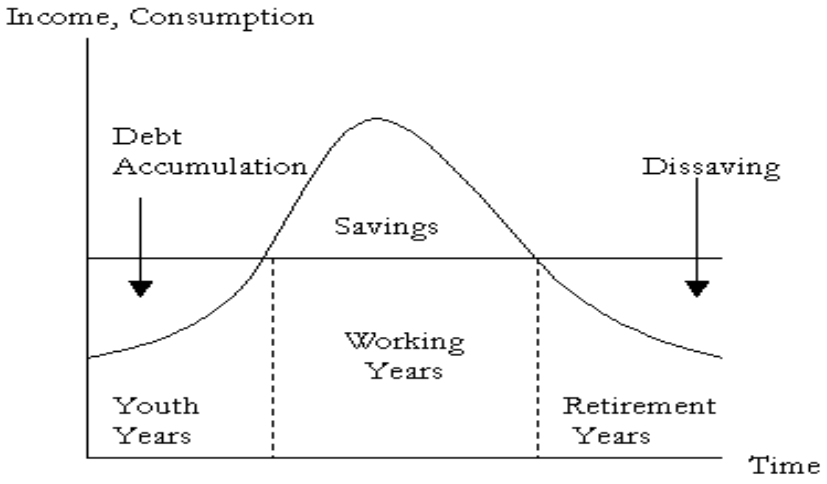
implications are information sharing and credit scoring which will be presented closely. I am also making some extensions to the Jaffee & Russell –model to make it more suitable for this study. In the fifth chapter I present the Finnish market environment. I show the aggregate volumes of the market, the pricing of different lenders and analyze the findings through the modified Jaffee & Russell -model. In the seventh chapter I summarize the study and make the conclusions.

1.1 Reasoning for the existence of credit markets for consumer

This chapter's aim is to show some theoretical aspects why consumers want credit in different situations. It leads us to information asymmetry and difficulties the asymmetry produces. The need for the consumer credit seems quite clear in common sense. People are in different situations in their lives and have different need for the money. Some like to save and avoid credits, some sees lending as a way to smooth their consumption possibilities over a long time, some invest the credit in hope for revenue and some borrow money to buy food for their family. There are multiple reasons for borrowing but I will present a few that are brought up in economic literature.

According to the Permanent Income Hypothesis by Friedman (1957) consumer chooses his consumption in each period based on his current wealth and future expectation of income. It means that a current budget constraint can be overrun with debt if consumer believes that his future income can cover it. A consumer optimizes his utility over the lifetime and he can smooth his income differences by borrowing when the income is low and saving when the income is high. This can be visualized by taking into account The Life Cycle Hypothesis by Modigliani (1986). According to this model the life of a consumer can be considered to have three phases. First, in the youth years of the consumer his income is low and he takes a debt for consumption. In this stage the consumer is studying or working in a low-income job. He also has expectations that the income will rise in the future. The second stage is the working years and the income level becomes higher. In this stage consumer has excessive income that he uses to pay the earlier debts and make savings for the future. In the third and last stage the consumer retires and the income reduces again to a lower level. In this stage the consumer can use the savings to maintain a higher consumption level. See Figure 1.

Figure 1: The Life Cycle Hypothesis from Modigliani (1986).



Attanasio (1999) argued that the consumption behavior is changing depending on many factors and it is not as stable as the life cycle model predicts. The consumption habits may change during consumers lifetime depending on factors such as age, marital status and the size of the family. According to the basic model of Permanent Income Hypothesis the utility is based only on the consumption flows. Whereas, Bertola et. al. (2006) suggests that the consumer usually reaches the same utility level with different consumption volumes depending on the life situation. The main reason for this is the uncertainty of the income which is not taken into account in the permanent income hypothesis. To give an example lets think about the following situation. Consumer expects a raise in the near future and consider taking a loan to by a new car. The raise is not yet happened so the consumer feels uncertain about it. If he takes the loan and buys the new car, there is two options that might happen. First option is that the consumer gets the raise and has no problem of paying the loan back. This will increace his utility while he can cruize with a brand new car. The other option is that he does not get the raise and he has serious problems in paying the loan back. The new car might actually reduce his total utility because of the stress and head ache that he gets for trying to pay back the loan. In this way the uncertainty affects the decisions of a customer.

The uncertainty that the consumers face is related to the risk that are attached to certain decisions. Friedman (1948) argues that people act differently under a risk. Some are willing to

take more risk in hope for larger profits, some chooses always the safest option and others choose the risk level somewhere in between. The differences can be explained by preferences, temper and also the shape of the utility function. As Friedman puts it: "A dollar has more value for a poor man that for a rich". In the credit markets this different approach towards risk creates information asymmetry. The lender cannot know the borrower's risk profile and this increases the risk that the lender is facing. The lender do not know what is the probability that the borrower will be able to pay back the loan.

Many people are living in the wold of monthly expenditures. The house, the car, the furniture and the hobbies are often paid with a loan. The monthly income is divided between saving and consumption, but the consumption might have actually happened already before. The consumption is not optimized by the money on the bank account but more of what kind of loan expenditures one can hande with the monthly income. The new way to think seems to be often that new Volvo does not cost 40000 euro but 400 a month. I have only 2000 on my bank account, but I can afford to put 400 monthly on my car. The price of the goods might be less important than the financing arragements seller can offer. This can lead a consumer into serious problems if the income level drops suddenly.

As a conclusion there is clearly a need for the consumer credit and as we know, there also is a market for it. People will apply for a loan in different situations and there is an uncertainty factor attached to the loan payments. This leads us to the lender's problem of asymmetric information.

1.2 Time value of money

When we discuss about loans and the credit business it is essential to go through some of the principles of a time value of the money. The section is based mainly on Fabozzi (2010). Money has different values in time depending on few factors. First thing is the inflation. Prices are getting higher all the time and the value of the money decreases. The second is the uncertainty that is attached to the future payment. You cannot be sure that the person you give the money will ever pay it back. The person might go bankrupt, make a fraud or even die. Whatever the

reason there is always a risk of not getting the money back. The uncertainty makes lending risky and it has to be compensated somehow.

Because of the reasons mentioned above the loans carry interest or some other sorts of fees. A borrower has to pay a little extra for the lender to get the loan. The interest has to cover the inflation for the loan period and the risk of not getting the money back. The amount of the compensation or the interest depends on the agents that take part in the transaction. The bigger the risk is the higher the interest is. To take an example when you make a deposit to a bank you actually give a loan to the bank. You get a small interest for it as compensation for the inflation and for the risk that the bank will go bankrupt. You probably don't see the risk of the bankruptcy very big. On the other hand when you need a loan from the bank you are paying a higher interest. The bank does not have the same trust in you that you have for the bank.

1.3 Competition on the credit market

Competition differs on the credit market in different areas. According to Petersen & Rajan (1994) the location of a bank determines quite much of the competition. In 90 percent of the sample entrepreneurs takes loans from banks that lay within 15 miles from them. This, however, cannot be generalized into the Finnish consumer loan markets in 2013, but it gives one explanation for the different competition environments. According to Petersen & Rajan there is clear evidence how the level of the competition effects on the loan relationships. If the credit market is under a perfect competition the loan rates for new entrepreneurs are on a quite high level and the access to the credit can be limited. At the same time the lenders react to good payment behavior and reward good debtors with low interest rates. This leads to lower interest rates for well-known and more riskless borrowers. On the other hand in a more concentrated credit market a relatively un-known borrower can have access to the credit more easily and with a lower rate than in the perfect competition. This is possible because the monopolistic banks have more market power than the banks under perfect competition. They can lend money under the market rate in order to subsidize young firms on the start and then later on have share of firm's surplus. This means that in centralized credit markets the lending rates do not drop very fast. The banks offer higher rates for riskless firms than in the competed

markets. It seems that the competition limits the new borrowers to get an access for the credit and makes the profit sharing harder between the banks and the borrowers

In the monopolistic setting it is essential for a bank to price the loan so that the borrower chooses riskless projects that generate profits. If the loan is priced too high it generates a moral hazard for the debtor. If the return on the riskless project cannot cover the loan expenses then firm might be forced to take risks in business decisions. The banks market power determines the upper boundary of the interest rate. The more market power a bank has the more it can raise the interest rate above the competed market price as long as it does not lead to the moral hazard. This is essential when setting the initial interest rate for a new and unknown customer for the first time. After the bank learns to know the borrower it will see whether the firm is credit worthy or not. The lower limit of the interest rate is evidently set by the banks own cost structure and funding costs. It is clear that the revenues must cover the expenses in the long run if the bank wants to stay in the business. So the interest rate will lie between these limits and as the relationship between the customer and the bank continues the bank's market power will be the leading factor for the rate.

1.4 Market power of a bank

Where does the market power of the bank then come from? Berger (1995) has studied this question by running empirical tests on bank profits against measures of concentration, market share, managerial efficiency and scale efficiency. According to the study it seems that the managerial efficiency in the cost control had positive effects on the profits. Also the relative market share had positive effect on the profits. On the other hand, when controlling the market share the results showed that the concentration had a negative impact on the profits. So it seems that large banks with a large market share and the managerial excellence has a possibility to use market power and price loans over the market price. Similar results have been found on De Graeve, De Jonghe and Vennet (2007). They studied the Belgian banking markets between 1993 and 2002 with a data that covered monthly interest rates for different loan products. De Graeve et. al. found out that the banks with the largest market shares did actually price their loans higher than their rivals. According to the results of these studies it seems that

the biggest banks with a relatively big market share can use the market power in pricing with differentiated loan products.

1.5 Asymmetric information

There are different types of operators in the market. On the other side we have buyers and on the other side sellers. By the available information the operators make buying and selling decisions. The buyer considers if he can afford a good and is the good worth of the money. The seller considers if the price is high enough to cover the production costs and get some profit. If information is symmetric both the buyer and the seller know all the vital information that has an effect to the buying or selling decision. As a result we get an effective market where demand and supply meet with optimal price.

Phrase asymmetric information is used to describe situation where some operators possesses more information than the others. For example the seller might know that a product has a poor quality but the buyer does not know it. In a credit market a borrower might know he cannot pay the loan back but a lender does not know it. According to Jehle & Reny (2001) the asymmetric information typically leads to inefficient market outcome, as decisions of the operators would be different if all the information was available for all operators. The borrower or applicant has more information about his financial standing than the bank has. This means that the bank has to make the lending decision based on an imperfect information. For example a borrower might be in danger of getting fired and probably cannot pay back the loan. The borrower has a better knowledge about his financial standing but he might choose not to tell it to the lender because this would weaken his change of getting the loan. To reduce the informational asymmetry lender can gather information about borrower to find out how big risk of default borrower has.

An adverse selection is one form of how the information asymmetry occurs. In the credit markets it basically means that wrong kinds of customers are selected in the lenders loan portfolio. Lender tries to grant a loan to the good customers that pay back their loan in time. The real risk quality of a customer can be seen only after the loan is paid back or when payment

problems begin. The lender does not know it beforehand but he can make prediction based on the knowledge he has.

The lender can analyze the past loan contracts and borrowers' payment behavior to estimate the default risk of a certain type of applicant. The bank can look similar characteristics among the good payers and give loan to the people who share these features. The problem here is that a lender has a very limited sample of the whole population. He knows only the payment behavior of his own customer pool. That sample might be biased and correlations might not fit to the whole population. This might lead to situation where the lender's portfolio and lending decisions suffer from adverse selection that might expose as a higher default risk that was planned. It can have also very dramatic effects on the lender who calculates the price of the loan so that it covers the cost and the risk of the default. If the risk is bigger than believed the defaulted loans raise the costs for the lender and might in the worst case lead to a bankruptcy of the lender.

Blöclinger (2005) introduces two kinds of biases that relate to the adverse selection. First is an α−type and the second is a β−type. The α−type refers to a situation where a lender assigns low risk on the borrower but the debt results in a default. This relates to a low quality risk identification or just bad luck. The β−type error refers to a case where lender assigns high risk to a borrower when risk in fact is low. When loan is not granted it brings no interest income to the lender. Both of these biases results as adverse selection in lenders loan portfolio, as he cannot identify desired borrowers.

The problem of adverse selection is very essential in the view of pricing the loan. The lender assumes a certain risk level to the loan portfolio and prices the loan product according to it. The price or the interest rate income must cover upcoming credit losses and if there will be more losses than expected it will soon eat the profits of the portfolio. If a bank cannot make profit it cannot pay the funding costs and soon it will be in bankruptcy.

Another important form of the asymmetric information is a moral hazard. This concept means in credit market that borrower will choose not to pay back the loan for some reason. The main implication would be scenario where borrower sees the cost of paying the loan back higher

than not paying it. Another implication of moral hazard is that too high interest rate will make the borrower to take risks that he would not take if the loan contract was better. For example entrepreneur might choose a project with a high risk to be able to cover the upcoming loan payments and this way increase the risk of default.

The lender must try to reduce the information asymmetry as much as possible in order to avoid the adverse selection and moral hazard. The lender can never know the exact default risk of an applicant but there are certain tools that can help the estimation. To analyze the problem of information asymmetry in the loan markets I will present a simple model about loan markets. From that model we see the dynamic that the adverse selection and the moral hazard has regarding the loan size and the loan sum.

2 The Jaffee & Russell -model about loan markets

I chose this model for the study because it has characteristics that fit well into the consumer credit market. It has no collateral assumption and it has clear interpretation about informational asymmetry. There are many good models about loan markets available but they usually include the collateral for credit rationing purposes and they also assume that the lenders are in fact banks that take also deposits. For my purposes the model by Jaffee & Russell fits better because the Finnish consumer credit market consist many lenders that are not banks. The funding of the lenders is not coming from the deposits but from the money market and other sources. The Jaffee & Russell –model is also quite simple and relatively easy to understand. The first disadvantage of this model is, however, that it works in a two period world and loan product is very simple bullet type loan. In the reality consumer loan contracts typically run for multiple periods and are somewhat more complicated regarding the pricing and the calculations. Secondly, it aims on finding single market equilibrium while the market analysis shows quite large differences in loan prices. The third problem is that it overlooks the resource differences of the lenders. However, it gives a good understanding of the mechanisms how information asymmetry effects on the loan contracts. To see other models with different characteristics and complexity I would suggest Besanko & Thakor (1986) and Stigliz & Weiss (1981).

Jaffee and Russell (1976) present a model about imperfect information in the loan markets. The model starts from the idea that the borrowers know if they are going to pay back the loan or not, but the banks do not know it. We can assume that on the market there are two types of borrowers: *honest* and *dishonest.* The honest will take the loan if the interest rate is such that the loan increases his utility more than the paid interest rate decreases it. If the interest rate is too high he do not take the loan. The dishonest borrowers will take the loan whenever they can. They will also pay it back, but only if their utility of paying the loan back is larger than defaulting the loan. This means that if the interest is too high the dishonest will not pay back the loan because the cost of defaulting is smaller than the loan payment. The lender does not know which group a borrower belongs. If he would know it the dishonest would not get the loan. This information asymmetry creates a problem of how to price the loan. To avoid all defaults the lender should set the price low enough, so that also the dishonest will pay it back. This might be problematic as the bank has to cover the all the costs of funding the loan. This funding price creates a lower boundary for the interest rate. When the interest rate is raised on higher level there are three effects taking place. First, the gross income per loan will increase which benefits the lender. Second, the fraction of honest borrowers will start to decline as the net utility of taking the loan will decrease. This results in the adverse selection and more risky loan portfolio for the lender. Third, the dishonest will start to default as their net utility turns to negative while the interest rate grows and we see the moral hazard. This is a somewhat clear interpretation about how adverse selection and moral hazard works in the loan market.

2.1.1 Demand

The model is a two period model with multiple banks and borrowers. The borrowers are divided into two categories: *honest and dishonest*. The banks do not know the type of a borrower at the start of the first period. During the first period the borrowers reveal their type to their own bank by either paying the loan or not paying the now. Other banks do not see the type. The borrowers are maximizing their utility over two periods. On the first period they can consume their income Y_1 and the loan sum L. On the second period they has the income Y_2 but they can consume only what is left after the loan payment L*R. The honest borrowers are maximizing their utility function:

$$Max\ U[C_1, C_2]\ with\ respect\ to\ C_1\ and\ C_2$$

Subject to

$$C_1 = Y_1 + L$$

$$C_2 = Y_2 - LR$$

Where:

U = total utility

C_1 = consumption in period 1

C_2 = consumption in period 2

Y_1 = income in period 1

Y_2 = income in period 2

R = interest rate factor (1+r)

L = loan amount $C_1 - Y_1$

We can now insert the budget constraints into the utility function:

$$Max\ U[Y_1 + L, Y_2 - LR]$$

By taking the partial derivatives subject to L we get first order condition (FOC):

$$\frac{dU}{dL} = U_1 - U_2R = 0$$

Borrower's total utility is maximized when the utility U_1 in the first period equals the utility U_2 in the second period times the interest rate factor R. From this we can now make assumptions about the loan demand. First we will assume that the income on each period is fixed. After that we can see that the only things that affect the utility are the loan sum *L* and the interest rate *R*. To satisfy the FOC they must react to each other. The borrower will optimize the loan sum subject to the interest rate so the loan demand is a function of R.

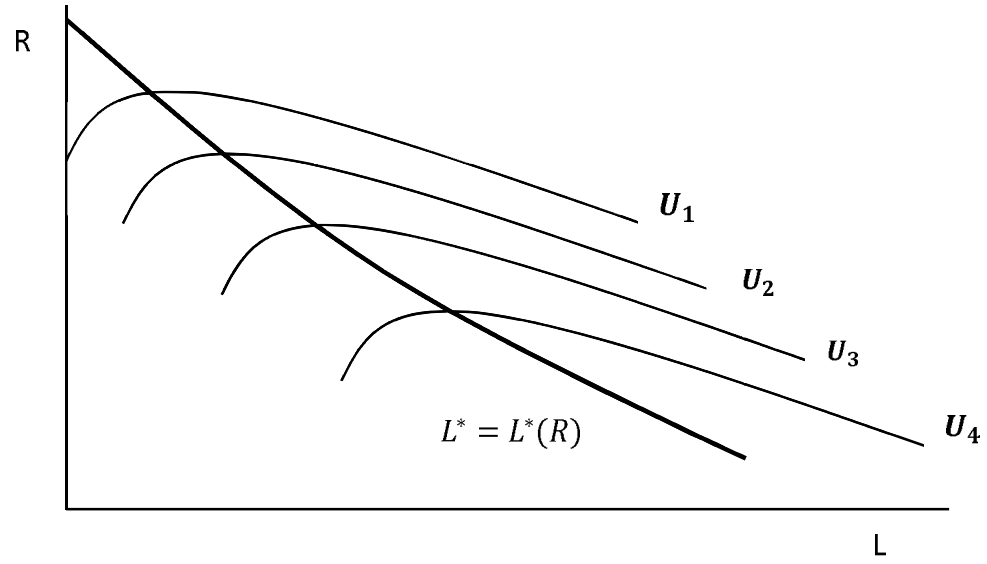
$$L^* = L^*(R)$$

To illustrate the demand curve in LR space we can draw Figure 2. On the Y-axis is the interest rate R and on the X-axis is the loan sum L. The curves U_1, U_2, U_3 and U_4 illustrate different indifference curves so that $U_1 < U_2 < U_3 < U_4$. They can be drawn by giving constant utility levels *K* for the utility function and calculating different RL combinations that yield K.

$$U[Y_1 + L, Y_2 - LR] = K$$

On the selected interest rate the borrower will reach the highest utility by increasing the loan sum L until $U_1 = U_2 R$. On the picture this point is where the utility curve reaches the highest point and has a zero slope. The loan demand curve $L^* = L^*(R)$ is formed by drawing a line that goes through these points.

Figure 2: Formation of the loan demand curve



The dishonest borrower has same the constraints than the honest in the case he decides to pay back the loan. In addition to that he also has alternative constraints for the case when he chooses not to pay and default the loan. So the dishonest borrower has two different constraint sets:

For the pay back scheme he chooses the consumption levels of:

$$C_1 = Y_1 + L^*$$

$$C_2 = Y_2 - L^*R$$

And for the default scheme he chooses consumption levels of:

$$C_1 = Y_1 + L^*$$

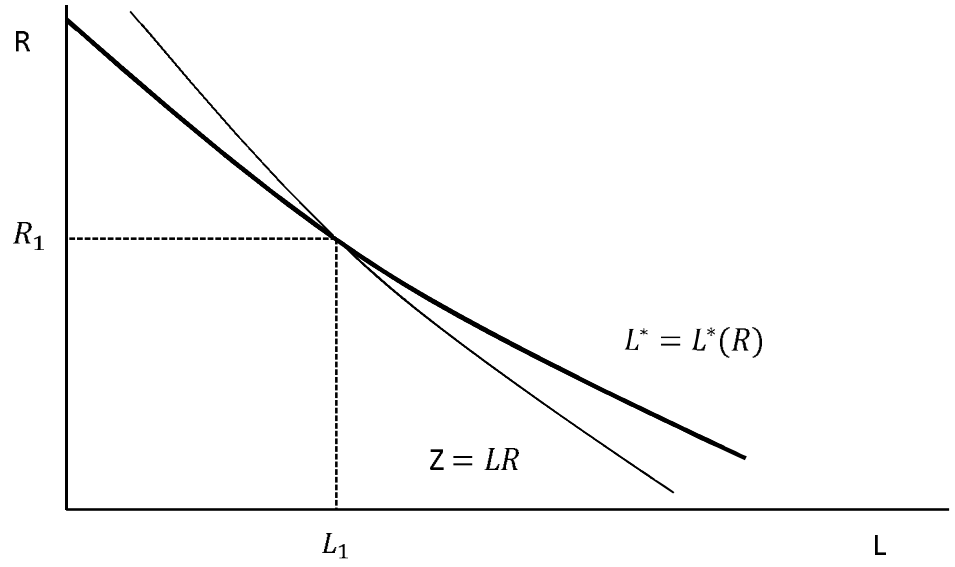
$$C_2 = Y_2 - Z$$

Where variable *Z* describes the cost of default.

The dishonest borrower will always choose the default scheme if it brings more utility to him. From the two equations of C_2 follows that the dishonest will choose default scheme if:

$$Z < L^*R$$

Figure 3: Demand for honest and dishonest borrowers



The dishonest borrower chooses not to pay the loan back if his cost of defaulting is smaller than the cost of paying back the loan and the interest rate attached to it. This is a form of moral hazard that is created by contract type that encourages dishonest borrower to default the loan. Figure 3 visualizes the alternative constraint set by adding the default points of the dishonest borrowers into the same picture with the loan demand of honest borrowers. The L^* curve is the same than in the Figure 2 and the Z-curve describes the maximum interest rates that dishonest

will pay for each loan sum rather than default the loan. These are the points where *LR = Z*. We can see that there is a point (L_i, R_i) where increase in loan sum with given interest rate will result as default for dishonest borrowers. The borrower chooses between payment and default so after the default curve goes under the payment curve the default will bring borrower on higher utility level. On loan sums smaller than L_i also the dishonest will choose to pay back the loan, because pay back option gives them higher utility.

We have now assumed that borrowers are either honest or dishonest type. That would not be very realistic assumption about the real loan markets. People have different situations in their life and the default costs are different for individuals. These costs can be economic costs that will be realized in collection etc. but also reputational or moral costs like getting your name into a default register or losing your reputation in the eyes of other people or even getting a jail sentence. Entry to default registry can lead to situation of not getting any loans in the future, rejection of a credit card or a rental agreement for a flat.

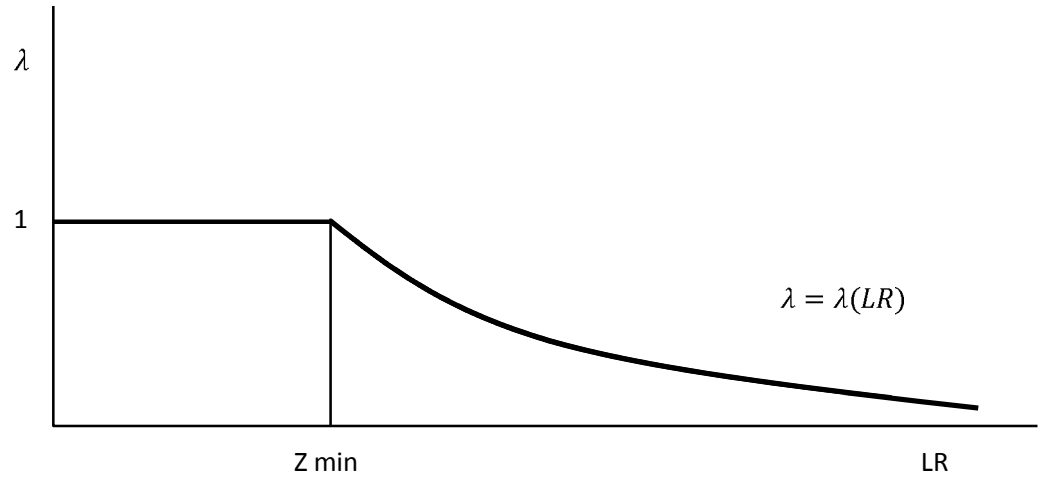
In this model the different default costs can be taken into account by adding a function

$$\lambda(LR)$$

This function represents the fraction people who do not default and act honestly on a given loan contract. It is continuous function of LR. The $\lambda(LR)$ = 1 when even the most dishonest borrower will not default with the given loan sum and interest rate. Function is also declining: as LR grows the proportion of the people who chooses to pay back the loan decreases. When LR grows near the infinity λ will approach 0. To visualize this we can look the Figure 4. On the Y-axis there is the fraction of honestly acting borrowers and on the X-axis there is the loan contract LR. The Z_{min} is the point where the loan contract turns into such that part of the population starts to get higher utility by defaulting the loan than paying it back. When we move to right on the X-axis we see that the fraction of honestly acting borrowers decreases. When the loan contract LR grows the relative costs of defaulting gets smaller and more people will choose to default.

We have assumed that the income streams of the borrowers are fixed. In reality this obviously is not the case. People face uncertainty for the future incomes and economic situation can change very fast as result of getting fired or having an injury that prevents individual from working. It is thus reasonable to think that the borrowers actually optimize their utility over expected income stream. We can fit this into the model by changing the fixed income Y_2 to be the expected value of the income. This does not change the behavior of the borrowers as they optimize the consumption over the expected income. The formula $\lambda(LR)$ will still be the fraction of borrowers who pay back the loan because their utility of paying with the realized income is higher than utility of not paying.

Figure 4: Fraction on borrowers who pay the loan back on loan cotract sizes



2.1.2 Supply

The lender is trying to maximize the value of the loan contracts. To be more accurate he is maximizing the expected value of the profits because he does not know how big proportion of the borrowers will actually pay back the loan. In this model lender's only cost is the funding cost of the loan and there is an unlimited supply of funds for the lenders. The profit function of a lender is form of:

$$\pi = LR\lambda[LR] - LI$$

Where

π = profit

L = loan sum

R = interest rate parameter (1+r)

$\lambda[LR]$ = fraction of borrowers who do not default at the given loan contract

LI = cost of funds for the bank

The first part of the function describes the expected income of the bank. It is the income from the loan contracts multiplied by the probability of repayment. The lender knows the fraction of dishonest people in the market but do not know the amount of those in his contract portfolio at the start of the first period. In the competitive market individual lender's profit must be zero. By adding that constraint into the function we can produce a credit supply curve:

$$R\lambda[LR] = I$$

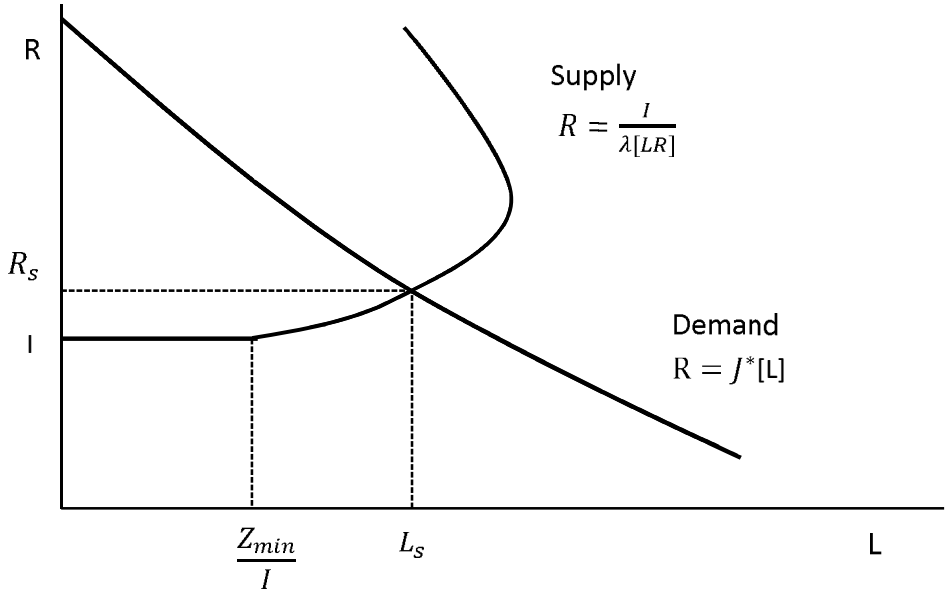
2.1.3 The non-rationing single contract equilibrium

Now we can recall that in the *RL* space $\lambda[LR]$ = 1 before the point (L_i, R_i). This means that the market rate *R* for the loan equals the funding cost *I* for a lender. The loan sums greater than that introduces uncertainty for the loan payment. From that point on the dishonest borrowers that get higher utility for keeping the money on themselves starts to show. Remember that each dishonest borrower has individual cost for the default. When the relative interest start to grow the borrowers with a low cost of default will start to default but those with a higher cost of default will still choose to pay. While the relative interest rate continues to grow it exceeds more and more default costs of individuals. Thus the proportion $\lambda[LR]$ will fall and the uncertainty of payment grows. We can now illustrate the equilibrium in the case of no credit rationing on the lenders side. On the Figure 5 the demand and the supply curves are presented as inverse functions of a loan amount. The market rate will find equilibrium at R_s with loan sum L_s.

The supply curve has some unique features. It is assumed that for the interest rate R = I there is a maximum loan sum that can be given so that every borrower will pay. This means that the R = I is so low that all borrowers will pay the loan back until the loan sum reaches a certain level. The condition R = I can only hold when

$$L \leq \frac{Z_{min}}{I}$$

Figure 5: Market equilibrium when no credit rationing is allowed



After the loan sum exceeds the $\frac{Z_{min}}{I}$ the proportion of those people who does not pay back the loan starts to grow from zero. This will cause the interest rate to increase because otherwise lender's profit would turn to negative. After that point the shape of the supply curve is dependent on the distribution of default parameter λ. It can be positively sloping if λ has the Pareto distribution without a distribution mean. If on the other hand λ is distributed exponentially the slope will be backwards bending. Like Jaffee and Russell I am presenting here the backward bending model. It illustrates the situation where lenders do actually decrease the loan sum provided if the interest rate is growing over certain point. This might actually be true in real world as the adverse selection and moral hazard are increasing when interest rate is high. Lenders can see that if interest rate is too high the loan contracts will become more and more risky. This choice should not, however, have effects on the main results of the model.

There exists an equilibrium point (L_s, R_s) where supply curve meets the demand curve with non-profit constraint for lender. From the equilibrium we can see that when the lender cannot

identify the risk of a borrower he must raise the lending rate for all the borrowers. This means that the honest borrowers will pay higher interest rate than they should and compensate the costs that the dishonest borrowers are causing for the lender. From the individual lender's side this is also problematic as he cannot know the type of a borrower when he is giving the loan. If lender happens to give the loan only for the dishonest people it will be end for his business as larger fraction of the borrowers will default on him.

Next I will go through the model extension for the case of credit rationing in which we look at the situation where lender will have the change to try to identify the risk of the borrower.

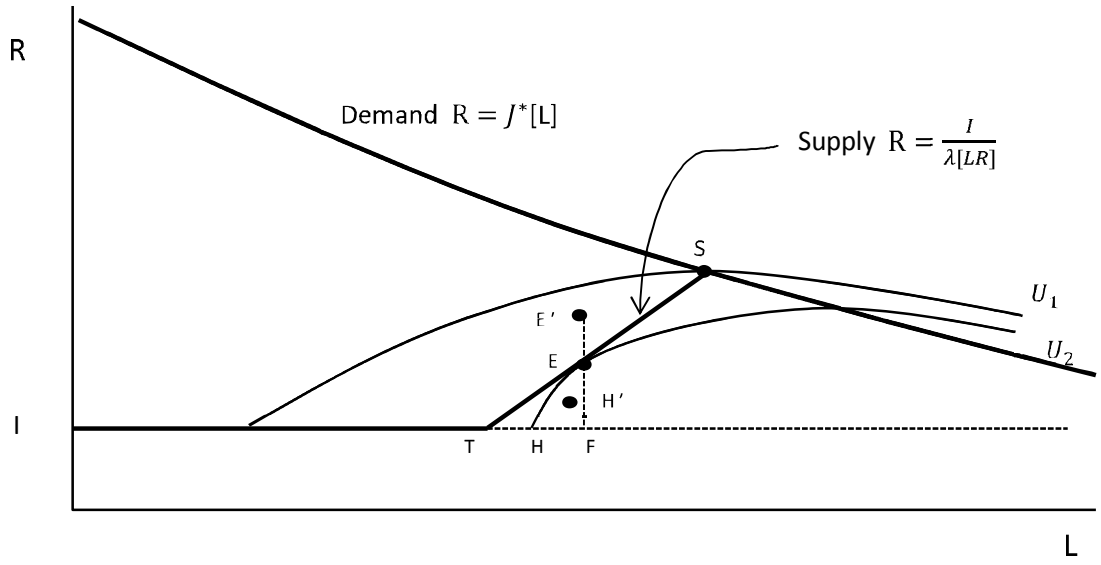
2.1.4 Rationing equilibriums with a single contract and multiple contracts

On the previous equilibrium there was a single interest rate for all the borrowers and it was found from the crossing point of the demand and the supply. However, on the real loan market people see different interest rates and banks try to find ways to figure out the risk that is attached to the borrowers. We can look this kind of situation also in the Jaffee & Russell –model in the Figure 6. Let's first consider that there exist only loan contracts that locate below the demand curve and that the zero profit condition holds. On the non-rationing equilibrium S borrowers have the utility U_1. The honest borrowers are now compensating the lenders with higher interest because the defaults the dishonest borrowers are causing. We can easily see that the honest borrowers would actually prefer any rationing contract under the U_1 curve as these contracts would yield them more utility. On the Figure 6 the line TS illustrates the part of the supply curve where the loan size exceeds point $\frac{Z_{min}}{I}$ and some of the dishonest people will start to default. Now, if lender could identify a borrower who is paying back the loan with contract *S* he could offer better contract E that locates on the supply curve and which borrower would prefer. The lender would not have to worry about the defaults because a borrower who is honest at contract S is also honest for all the better contracts he can get for loan sums that are smaller than in the S.

Next we can look all the different contracts a lender can offer if the credit rationing is possible. For the lender the supply curve *ITS* shows the lower limit for the contracts he can offer. Under that line all the contracts would be un-profitable for the lender because defaults will exceed the

revenue. The upper limit for the possible contracts is the iso-utility curve U_1 that runs through the non-rationing equilibrium *S*. Above that line borrower's utility would suffer and he would rather choose the contract S. Between these limits, the lender can offer any contract to the honest borrower and the contract will be accepted. The lender can offer contract *E'* to the honest borrower and this actually benefits both agents. The borrower gets better utility compared to S and the lender will receive extra profits as he operates over the supply curve. However, if the market works properly and the non-profit constraint holds then the competition will run the rationing equilibrium to the point E where the utility of the honest borrowers will be maximized and no extra profits will go to the lender.

Figure 6: Market equilibrium when credit rationing is allowed



It is also possible that some lenders can offer contracts that are on the area *HEF*. This can be possible because the dishonest borrowers will always choose the larger contract. They are not going to pay it back so why take the smaller sum? On the other hand, for the honest borrowers these contracts give higher utility. Thus, the honest borrowers will be over time self-selected to this better contract and only the dishonest will be on the contract E. This will lead to the situation that only the dishonest will take the contract E and the lenders that offer it will go bankrupt as all borrowers default. Now, the only contract that is on the market will be the H on

the area HEF and also the dishonest borrowers has to take that offer. At this situation supply must again move to the point E so that the non-profit condition holds.

In reality the market might not be perfectly competed. The lenders try to identify the risk that is attached to a borrower and manages in that task differently. On the other hand, all borrowers might not compare the prices to find the cheapest one. This gives interesting point to look for a lender's profit generation. The lender can get advantage against competitors if he can identify borrower's risk better than others. If the market price is on the non-rationing equilibrium *S* and one lender can identify an honest borrower that is seen risky or dishonest by the other lenders, he can offer rationing contract that is marked to the picture by E'. This gives possibility to extract extra profits from the loan contract and actually benefit the borrower as well. As we saw earlier the contract E' gives higher utility for the honest borrower if compared to S. Even in the well competed markets these situations can occur for a short time before the market will make the corrections. The same thing applies to the area under the supply curve. If lender can identify the risk of the borrower better than competitors he can extract profits from his own portfolio that is better in quality.

Next I will go through some recent research on the area of pricing to show that assumptions about shapes of the demand and the supply curves hold in real world as well.

3 Pricing

Pricing of the lending rate within a bank is mainly attached to three aspects: Cost of funding, managerial efficiency and risk. The cost of funding is mainly attached to the market rate for the short and the long money. According to Freixas and Rochet (1997) the market rates were the main drivers for the cost of funding and the deposit rates had no real effect. This follows the Monti Klein banking model's basic assumption that no significant risk premium has to be paid in the interbank market. In the recent banking crisis this might not hold anymore as confidence between banks has become weaker. In the Jaffee & Russell –model was assumed that the only cost would be the funding cost. We can extend the model and assume that the funding cost includes also all the other relevant cost. Individual lender might diverge from the average costs by operational excellence against others. However, the competition will drive the other lenders

to improve their cost structure so that they can match the prices of the better lenders or they will go bankrupt as honest borrowers will disappear from their portfolio.

3.1 Loan size and its effects on price

The effect of the loan size to the price of the loan has been noted already early in the literature. There is also empirical study to back up the assumption made in the Jaffee & Russell -model about the declining demand function. Already in the 1964 George J. Benston studied this topic and found clear correlation between the loan size and the pricing. He noted that banks give lower rate for a larger loan and higher rate for a smaller loan. According to Benston there were two explaining factors. First was the managerial cost per dollar for different the loan sums. Benston found out that the managerial cost per dollar was lower for larger loan than for smaller loan. This makes sense because it can be assumed that a loan process is the same for each loan in the same loan type despite of the loan amount. Further, if the process is the same and costs are similar then the administration cost for dollar is lower for bigger loans. The second explanation for the price difference is that banks are discriminating against smaller borrowers. In this point of view it must be stated that smaller loan applicants have more limited access to the credit and banks have thus more negotiating power. Large borrowers have to qualify better in the application process because the credit risk that bank faces is bigger for the larger sums. It is also common to give collaterals for the loan as the loan size grows. Thus, it can be assumed that the larger borrowers are considered to have better quality in risk terms or at least they have to clear tighter lending policy in the applications process. This hypothesis is backed up also with Benston's finding that in the years when money supply is tighter the small borrowers face relatively bigger rise in loan rates than the large borrowers.

3.1 Price elasticity

The formula for price elasticity of demand is:

$$price\ elasticity = \frac{\%\ chance\ in\ quantity\ demanded}{\%\ change\ in\ price}$$

Price elasticity measures how much demand change if price is changed. More accurately, it shows how many percent demand changes if price increases with one percent.

A recent study has found somewhat different results regarding the size of the price elasticity of consumer credit. Gross and Souleles (2002) made a research of the price elasticity of credit card markets in the U.S. They studied about how much the credit card balances reacted for the price changes during the contract. They found that the price elasticity was on the average -1,3. The elasticity was highest for balances near the credit limit and another finding was that the elasticity was higher for the price decreases than for the price increases. A credit card contract is, however, little bit different than a fixed loan contract. If people have different credit card limits it is relatively easy just to transfer the balance from one card to another when they have different prices. Still, according to Gross & Souleles under half of the elasticity was explained by the balance transfer.

Another study about the price elasticity was made by Karlan and Zinman (2006) in South Africa. They studied the price elasticity of microloans by sending offers to borrowers who had been earlier customers of the bank. They found out that the price elasticity was an average -0,3 and all observations were under -0,5. The elasticity was higher for those borrowers that were known to be less risky and the poorer ones did not react so much on the price. This makes sense in the way that people with more stable economical standing do not need the loan so much and has thus more negotiation power against banks.

The results are in line with the demand curve of Jaffee & Russell –model. The study of price elasticity of demand in consumer credit market shows that the demand curve is downward sloping. The size of the elasticity differs in these two researches presented, but also the products and markets differ from each other. There were also some other differences. Karlan & Zinman showed that the demand was more sensitive for the price increases and on the study of Gross & Souleles the demand was more sensitive for the price decreases. This might be linked to the market environment or the fact that people react differently on the price of loans they already have. Either way, this discussion will be left for further study.

3.2 Risk based pricing

The risk based pricing is a form of a price differentiation. The idea is to recognize borrower's risk profile already in the application phase and set the price of the loan according to it. So,

lender will set a higher price for a loan if the credit risk seems high and a lower price if the risk seems low. In consumer credit market this pricing phenomenon has become more common after the beginning of 1990's. Edelberg (2006) showed that in US the risk based pricing has been used increasingly in the consumer loan market after the early of 1990's. The study shows increase in the interest rate spreads between different borrowers in securitized loans. However, among the un-securitized loans only the credit card interest rate spreads rose while in the student loans and other consumer loans the spreads remained stable. Edelberg showed also that price changes did have effects into the loan demand. While the whole amount of credit rose in the observation period the increase and the benefits did not fall on every risk class uniformly. Firstly, the risk based price discrimination had benefits for the low risk borrowers as their interest rates fell. The data shows that this population increased their total lending during the observation period. Secondly, the highest risk population benefitted for a better access to the credit. Although their interest rates were relatively high they could actually get a loan as opposed to before. Thirdly, the moderately high risk population observed relatively higher interest rates than before and they did change their borrowing patterns. This showed a decline in credit amount among this population. It seems that the middle class of borrowers suffered of the risk based pricing through higher cost of credit. While risk based pricing has positive effects for some borrowers everybody does not win. Part of the increased credit risk was channeled to the marginal of the middle class of the borrowers.

The observations of risk evaluation and risk based pricing are suggesting that there exists credit rationing in the credit markets and there are different loan contracts offered to the borrowers. This means that the lenders can evaluate the risk of borrowers while some information asymmetry still exists. Lenders can identify the borrower's default costs roughly and price the loan so that the most of the honest borrowers gain for the contracts but the middle risk borrowers has to pay compensation for defaults.

4 Evaluation of the borrower's default risk

In this chapter I go briefly through history of credit risk modeling. I will introduce two main tools that are used to reduce a lender's information asymmetry. These are the information

sharing systems and the scoring models. Both of these are used to back up the lending decisions and to identify applicant's default risk in order to reduce adverse selection. It seems that an effective automated identification of default risk can be done and it has positive effects for lenders profits. To look more into this see for example Blöchlinger (2005). The Information sharing has shown to have multiple positive effects not only for the lender but also for the borrower and the whole credit market. After the information sharing and credit scoring I will discuss how they can be inserted into the Jaffee & Russell –model. I will also show the dynamics they have on the supply curve and the equilibrium points.

4.1 Information sharing

To reduce the information asymmetry there have been created information sharing systems in the majority of the countries according to two major researches made in last ten years (Jappelli and Pagano 2005, Miller 2003.) These researchers discovered considerable variation in the threshold of filing a credit report. In some countries already the loan exposure was enough for personal credit report that could be checked by other lenders. In other countries only the default was registered. A lender can ask for borrower's credit report from the credit bureaus that hold the register to find out if the borrower has over indebted or has a bad payment history.

Recent research has showed that information sharing has many positive effects on the markets. I will introduce four positive impacts that have been found:

1. Reduction of the adverse selection as lenders knowledge of borrower improves
2. Reduction of the "informational rents" that lenders will extract from customers
3. Enhanced borrower discipline by cutting insolvent debtors off from the credit
4. Reduction of over indebting by drawing many simultaneous credits from different lenders

Jappelli and Pagano (1993) studied these impacts of the information sharing. In their model each bank knows the behavior of their local borrowers but behavior of non-local borrowers is

unknown. The adverse selection is thus higher with the non-local borrowers because of the lack of information. By sharing their knowledge with the other lenders banks can reduce the information asymmetry and thus also adverse selection. As banks can lend more to safer customers it will enhance its credit portfolio quality. The lender can lower the risk premiums as cost of asymmetric information reduces, which will eventually result as smaller interest rates to the borrower. Padilla and Pagano (2000) argued that the information sharing also enhances the borrower discipline. While the lenders share the information, the borrowers in the default register will be facing higher rates as a penalty for bad payment performance. A borrower will try to avoid this and exerts more effort to the loan payments. The fourth part can be achieved only in limited case where the lenders share the outstanding loan exposure in a positive loan register.

In Finland the leading credit information sharing platform is the Suomen Asiakastieto register according to The Finnish Competition and Consumer Authority. It is a public register where lenders can inform the customer's defaults. The register holds information about type and amount of the defaulted loans, the bankruptcies and the official loan arrangements. Lenders can also report a notice if borrower's payments are delayed enough. In big part of the EU there is a positive loan register on markets. According to Rothemund & Gerhardt (2011) credit bureaus of 18 member countries actually hold a positive register that contain all the loans that individual consumers hold. The negative registry which contains only the default markings was even more common and 23 nations stated that they hold negative information.

In my field study I noticed that while there is a negative payment registry for all lenders there is also positive registry that part of the lenders use. While the negative registry is mandatory for operators the positive registry is voluntary. A lender has to ask from the borrower if he is approving that lender will use this register and check borrower's information from the registry. The registry contains information about following variables:

- Count of outstanding loans
- Loan sums
- Size of loan payments

- Sum of loan payments on due

On 23.4.2013 there are 15 lenders that use the register. While this register is only couple of months old it is quite interesting that the whole lending industry is not choosing to join in it as it evidently brings more information about borrowers. One reason might be that the registry is voluntary on the borrower's side. If borrower has something to hide he won't probably give permission to the lender. This can be easily be interpreted as a sign of some negative information but it can also mean that the borrower is simply not comfortable of sharing information of his loans to anyone. Another reason might that at least the large banks that hold large customer portfolios want to keep the knowledge about their own customers by themself.

4.2 Credit scoring

The roots of credit scoring leads back to the 1960's when credit cards were introduced in the US. The amount of credit card applications forced the issuers to develop a standardized form for credit decisions. Until that individual experts made the lending decisions. They considered applicant's financial standing to make the lending decision based on their professional opinion. According to Thomas (2000) in the 60's the daily amount of applications became so large that there was no other change but to automate the lending decisions. This was proved to be an effective way to drop the default rate. Churchill, Nevin and Watson (1977) showed that this process automation reduced the credit defaults at least 50% comparing to the individual judgment of applicants. Also Rosenberg and Gleit (1994) found out that credit experts produced somewhat less accurate risk classifications than the statistical methods.

Since the credit scoring had brought good results in the credit card markets, banks started to use them in other products as well. At first the scoring was implemented to the personal loans and more recently to the mortgages and small business loans (Thomas 2000).

Basically the credit scoring means estimation of a customer's behavior by some statistical analysis. The credit scoring is used to estimate the default risk of the customer, based on the application information. Thus, the information that is gathered about a customer should be useful considering the loan decision. The lender has the application information, the

information held by credit reference agencies and recent payment history in case of an old customer (Thomas 2000.) In addition to these the lender also has a mass of information of the previous applicants and their payment behavior.

The idea of a credit scoring system is to find different factors that are considered to demonstrate the applicant's financial standing. Each variable will give points based on the information gathered about the borrower. After the scores have been calculated the lender can put borrowers in order based on the credit score. On the bottom there are the applicants with the lowest scores and on top the applicants with the highest scores.

To see what kind of information is used in the credit scoring models I will introduce one basic model that is presented by Kainulainen (2004). This model is Suomen Asiakastieto's Suomi Credit and it is designed for the Finnish credit markets. The model is based on a logistic regression analysis and it contains eight variables that are considered to predict the default risk:

1. Age
2. Profession
3. Income
4. Residential status
5. Gender
6. Geographical location
7. Marital status
8. Length of current employment

Different values of these variables are given certain scores and the sum of these scores will give the overall credit score of the applicant. This is a basic model that can be programmed to match different companies' needs (Kainulainen 2004.) In this model every variable is divided in different segments. For example 'Age' could be divided into groups of 18-25, 26-40, 41-60 and

60-. Now, to each of these segments the lender attaches a certain score. For example one point if the age is 18-25, two points if the age is 26-40 and so on. This is done to all the variables and a customer will have an individual score based on his individual features. After customer's score from all variables are counted the lender knows applicants total score. If the applicant gets enough points he will get the loan. The minimum score for a positive loan decision is called *a cut off rate*. The cut off rate demonstrates how tight the loan policy is in a lending firm. If the firm likes to get a small but well performing loan portfolio it raises the cut off rate so that only a small fraction appliers will get the loan. If the firm wants to make business with more risky borrowers and have a large loan portfolio it will lower the cut off rate (Blöchlinger 2005).

Table 1: The example scorecard from Rosenberg and Gleit (1994)

OWN/RENT	OWNS 45	RENTS 18	ALL OTHER 24			
YEARS WITH EMPLOYER	UNDER 1 YEAR 15	1 TO 2 YEARS 22	3 TO 4 YEARS 26	5 TO 9 YEARS 26	10 TO 12 YEARS 29	13 YEARS & OVER 36
CREDIT CARD	CARD 19	NO CARD 0				
FINANCE COMPANY	YES 0	NO 36				
BANK ACCOUNT	CURRENT + DEPOSIT 50	CURRENT 31	DEPOSIT 32	NONE GIVEN 15		
OCCUPATION	PROFESSIONAL/ EXECUTIVE 29	MANAGER/ SEMI-PROFES-SIONAL 28	OFFICE STAFF 25	PRODUCTION 15	SALES 22	ALL OTHER 15
PREVIOUS ACCOUNT	UNSATISFACTORY 0	NEW 55	SATISFACTORY 87			
CREDIT BUREAU	NO FILE 15	DEROGATORY RATINGS −33	1 OR 2 SATISFAC-TORY RATINGS 24	3 SATISFACTORY RATINGS & UP 30		

The Table 1 shows one kind of scorecard that is presented by Rosenborg and Gleit (1994). From that can be seen the different scores that are attached to the different variable values. From each row the applicant will get a certain amount of points according to his individual attributes. The applicant will be scored by counting all points from the rows together.

By a statistical analysis the lender can search similarities in the group of the defaulters. According to Thomas the lending organizations usually have a record of hundreds of thousands

or even millions of loans. Banks' records hold assumedly at least the application information and the payment performance. From this data it is possible to find factors that seem to have an effect to the individual credit risk. As the relevant factors are identified they can be implemented into the loan decision process. This gives an idea of how the scorecards are developed.

The scoring models can be divided into two different types which can be used for lending decisions: Credit scoring models and behavior scoring models. These are used in two different situations. The credit scoring models are used when lender makes a credit decision to a new customer while behavior-scoring models are used in the case of an old customer. So the credit scoring models work with application information and the behavior scoring models work with known payment behavior of the customer.

There are many different scoring models in the market but the basic idea is the same in all: find the factors that correlate with the defaults and make the lending decisions based on that information.

4.3 Methods used to create credit scoring model

In the economic literature multiple different scoring models have been introduced. These can be divided into two groups that are a discriminant analysis and operational research methods. The discriminant analysis contains linear regression models, logistic regression models and classification trees. According to Thomas (2000) the operational research methods are mainly based on linear programming. In addition to these there are also some other methods based on artificial intelligence programming. These AI models like 'Neural networks' are mainly used in business scoring and not in customer loans (Altman et. al 1994). The most common and the most studied models seem to be the discriminant analysis based regression models (Thomas 2000).

The basic idea of the discriminant analysis is that in the borrower population are two groups: G and B. G stands for a good customer who pays back the loan with no problems. Group B on the other hand consist of bad customers that do not pay the loan back. The groups can be studied to find similarities that could predict some sort of behavior. By making a regression analysis a

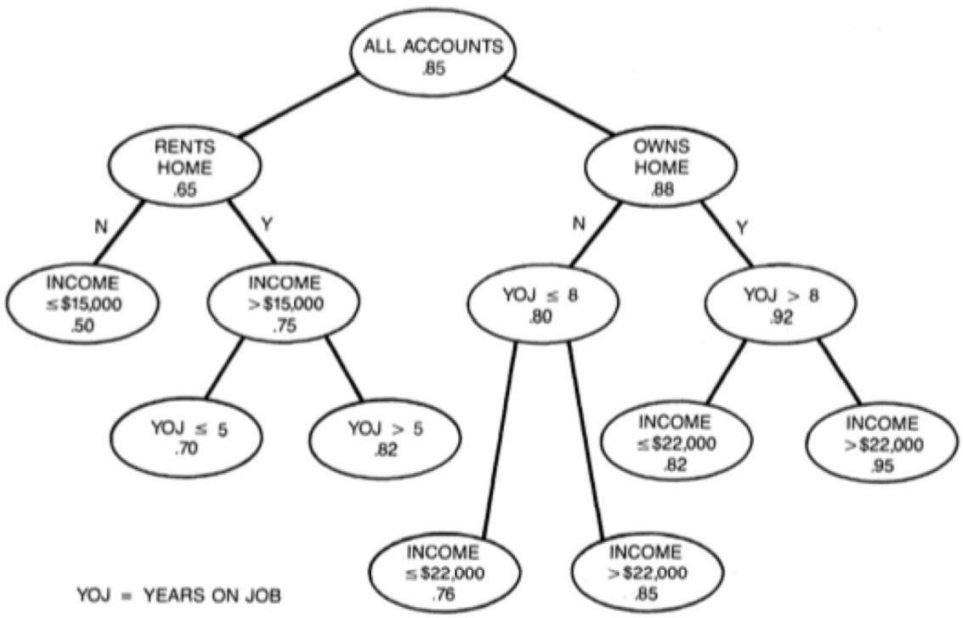
lender can now try to find similar features that defaulters have and similarities that good customers have. The lender tries to answer to questions like: Does the age have an impact to the customer's payment behavior? Does income class or marital status have correlation to default risk? When some explanatory variables are found the scorecard is built on these. The regression might be linear or logistic, but the idea remains the same (Rosenberg and Gleit 1994).

The aim of regression models is to find the right variables that correlate with default risk but not with each other. Then the weight of a certain variable leads to a probability that applicant with this variable belongs to group G. This gives us a score function of a basic linear regression where w stands for the weight and x stand for the variable value:

$$s(x) = w_0 + w_1 x_1 + w_2 x_2 + \ldots + w_m x_m$$

As the relevant variables have been found and scorecard have been designed the lender has to set the cutoff rate. In order to do so, the lender will calculate how much losses an average bad customer produces. By comparing this to how much a good customers gives profit the lender can optimize the profits with respect to the risk rate.

Figure 8: The decision tree from Rosenberg and Geit (1994).



Another discriminant scoring model is the decision tree that is presented in the Figure 8. The decision tree is based on an idea that first you find out which variable discriminates the most G from B. After this you divide the population into two groups according the variable. Next, you find out which is the second best variable for discrimination. Now continue to discriminate the two groups into smaller groups. After few rounds you have many different groups that have different risk attached to them (see Figure 8). The lending decision can be based on the comparison of the end node's default probability and the chosen risk level.

The Table 2 gathers the main research results that have been made in 90's. Different rows cannot be compared straight as the research methods have varied between authors (Thomas 2000). From the table we can see that there is not much of variation between different models. It seems that whatever the scoring model is it gives quite similar assumptions about the default risk within a certain study. Linear programming, neural nets and GA have not been studied as much as others and they also show a little bit worse accuracy than regression models.

Table 2: Comparison of accuracy of different scoring models from Thomas (2000)

Authors	Linear reg	Logistic reg	RPA	LP	Neural nets	GA
Henley (1995)	43.4	43.3	43.8	–	–	–
Boyle et al. (1992)	77.5	–	75	74.7	–	–
Srinivasan and Kim (1987a,b)	87.5	89.3	93.2	86.1	–	–
Yobas et al. (1997)	68.4	–	62.3	–	62.0	64.5
Desai et al. (1997)	66.5	67.3	67.3	–	6.4	–

In a more recent study of different scoring models (Heiat 2012) the accuracies of the models set between 75 % and 89 %. In this study all models has an acceptable level of accuracy but the SVM-model is clearly the most accurate. The SVM was able to predict quite correctly good credit out of the bad. To see Heiat's comparison results see the Table 3.

From these studies we can see that the scoring method is not standard for all operators. There are multiple different scoring methods that yield different accuracy on prediction power. Lender can develop his scoring continuously to gain advantage against competitors.

Table 3: Comparison of accuracy of different scoring models from Heiat (2012)

	SVM	C5	Bayesian Network	C&R Tree	CHAID	Logistic Regression	Neural Net
Overall accuracy	88.769	83.231	78.462	77.692	76	75.846	75.231
Lift (Top 30%)	1.771	1.655	1.667	1.59	1.631	1.581	1.657

The credit scoring depends on the information that is gathered partly from the registries but big part of it is asked straight from the applicant. While the registries have quite limited information about the consumers the lender has to depend on the application information that cannot be verified at all or the verification is difficult and costly. In Finland the credit registries contain information about negative payment remarks which is of course very valuable information. On the other hand the lender will have no exact information about the applicant's total loan exposure or the liquidity which the positive registry would offer. Lender can however inquire the tax decision documents or pay slips from the applicant. The tax decision contains information about loan exposure, interests and income from the previous year. The problem is that tax decisions are mailed to consumers approximately six months after a year has ended so the information is not current but from 6 to 18 months out of date. Every document that the lender requires from applicant makes the process more difficult to borrower so the risk of losing a customer grows.

4.4 Applications of information sharing and credit scoring in the Jaffee & Russell –model

In this section I am developing the Jaffee and Russell –model further to show effects the information sharing and the credit scoring have in this frame. First I present these two information tools and then show the effects on the equilibrium.

4.4.1 Information sharing

The amount of the information influences the quality of the risk predictions lender can make. Thus it can be assumed that an access to a loan register benefits the lender. The negative credit register is mandatory for all the lenders in Finland so this does not have effects on supply in Jaffee & Russell –model but affects the pool of applicants. It can be stated that the negative payment information is known to all lenders and the borrowers with negative payment remark are ruled out from the market. The voluntary credit register on the other hand does have implications on the model. The lenders that belong in the register have better knowledge about the borrower's current economic situation than those lenders who do not belong in the register. At the same time they must share the information about their own customers to those lenders who also belong in the register. In the Jaffee & Russell –model it was assumed that all lenders know the fraction of good payers in the total population but the positive register alters this situation if all lenders do not have the access to the register. I will assume that the access must cost something to the lender and it must be taken in to account in the model. To do this, I insert two new variables *A[C_A]* and C_A in the supply function. The *A[C_A]* describes benefit that a lender gains for the access to the register. It gets value *A=1* if lender does not belong to the register and constant value A>1 if he belong to it. The variable C_A describes the cost of access to register. The supply function of a lender then has the following form:

$$\pi = LRA[C_A]\lambda[LR] - LI - C_a$$

4.4.2 Credit scoring

I have now shown the principles of credit scoring and how it is used. It seems apparent that the credit scoring can lower the informational asymmetry that lender faces and can produce competitive advantage for a lender if he can get better risk predictions out of the scoring process. Similarly than the information sharing this should be taken in to consideration in Jaffee & Russell -model. The credit scoring can improve the lenders portfolio but at the same time the development of such system might be expensive. We can add two variables in the supply function to illustrate this. The variable $B[C_B]$ is describing the positive effect of getting better fraction of good borrowers and C_B describes the cost of the scoring system. It can be further assumed that $B[C_B]$ is growing in C_B. These scoring variables do not have effects on the

demand function as the variables are only affected by lenders choices. The supply function would then be in the following form:

$$\pi = LRB[C_B]\lambda[LR] - LI - C_B$$

4.4.3 Effects for the equilibrium

Both the positive loan registry and the credit scoring affects the credit supply similarly. They increase the lenders cost but at the same time they make lender's business more profitable. The lender can identify better the borrower's default cost. When the default costs are known to the lender he can give the loan only to the honestly acting borrowers on the given price. We can thus handle both of these with the same variable. A variable *X* will demonstrate the amount of information and the variable *I* which was the funding cost of the lender will be seen as a function of X. Also the fraction of the honestly acting borrowers is now presented as a function of X. The information cost could be handled separately from the funding cost like I presented them in 5.4.1 and 5.4.2 but this would make the model more complex. Lenders profit function is now:

$$\pi = LR\lambda[LRX] - LI[X]$$

Where:

π = profit

L = loan sum

R = interest rate

X = the information level a lender acquires with information tools.

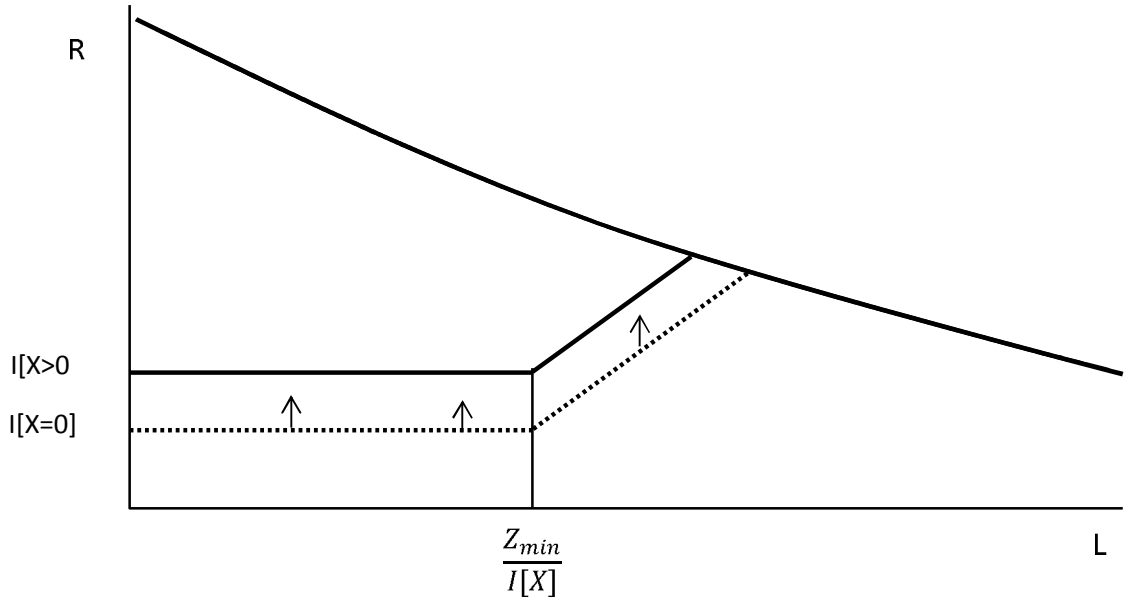
And the supply curve will be:

$$R\lambda[LRX] = I[X]$$

There are now two effects happening in the supply curve if we compare the situation on original Jaffee & Russell -model: *the cost effect* and *the portfolio effect*. If a lender earns more by investing in better information about the customer's default risk, he will do it. The

information level I[X] is set by investments X. This *cost effect* will push the supply curve upwards in the RL-space as I[X=0] < I[X>0]. This will also lift the equilibrium price. The Figure 9 is showing this effect.

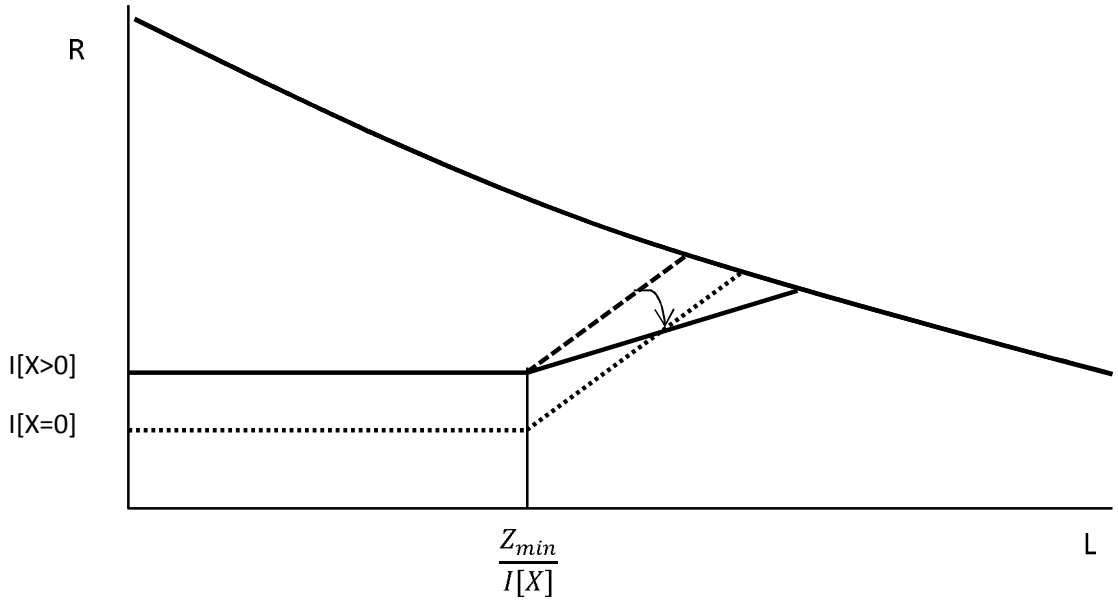
Figure 9: The cost effect of information purchase



The portfolio effect comes from the assumption that a lender can make better loan decisions if he has more information. The lender can identify better fraction of honestly acting borrowers and can offer better contracts to them. When the lender can acquire better performing loan portfolio it will bend the supply curve downwards from that point on where the dishonest people will start to default depending on their default cost. This is presented in the Figure 10. The lender can now identify borrower's risk better and offer the loan contracts only to those borrowers whose default costs are higher than the loan payment.

When the supply curve is bending down it also brings the equilibrium rate down. The total change in the equilibrium price depends on these two effects. It can increase it or decrease it depending on the size of the information cost and the portfolio effect. However, regarding to the literature I have presented earlier it can be assumed that the total effect brings the equilibrium price down and benefit the honestly acting borrower.

Figure 10: The portfolio effect of the information purchase



5 Consumer credit market in Finland

It this section I will go through some key numbers about the Finnish consumer credit market. I will focus mainly on a consumer credit excluding mortgages. Numbers are based on two authority references. First one is Annual Review 2012 of Financial Statistics of Finland published by Bank of Finland. This publication shows figures regarding the firms that are operating under banking license. The banking license is needed if a firm is taking deposits so the review does not take into account finance companies that finance their operations via other sources. The second reference is a database of Statistics Finland which gathers statistics from the banks but also from the finance companies. The Statistics Finland database is collected via surveys from the banks and the finance companies. The statistics can be considered quite comprehensive as the financial companies are obliged to provide needed data to the Statistics Finland according to Finnish law (Tilastolaki 280/2004).

5.1 Different products

In the Finnish consumer credit market the main products are credit card type of loans and fixed loans. The credit cards are having a certain loan limit that a borrower has and he can use that limit over and over again by paying the loan back in between. This means that the borrower has access to a continuous credit limit with only one application. The fixed loan, on the other hand, have a single contract for a certain loan sum and if the borrower wants a new loan after the original loan is paid back he has to make a new application. The fixed loans can be divided into two categories depending on whether the contract has collateral attached or not. The largest loans usually have collateral attached to them to cover some of the default risk the lender is facing. The smaller loan sums might not need collateral and lenders are preparing for the defaults with pricing decisions. The uncollateralized loans can be divided further into two categories depending on the loan sum. The larger consumption loans range from 2000 euros upwards and the small loans are under 2000. In the larger consumption loans the payment plans might be couple of years while the small loans are usually paid off with one payment few months after the loan is granted. I study the fixed and uncollateralized loan markets for larger sums so the other products are getting less attention. However, while legislation concerning the small loans is changing in the near future which will have substantial effects on that market I will cover some features of it because it has very similar characteristics than in the loan product used in the Russell & Jaffee –model.

5.1.1 Small consumer loans

During the last 10 years Finland has seen increasing market for the small loans and pay day loans. Statistics Finland characterizes these loans to be relatively small in sum and have maturity of maximum three months. These loans usually carry no nominal interest but other costs related to these are relatively high. According to Statistics Finland the small debt companies have been granting loans for 394 million euros in 2012. However, this business is going to face serious problems in the future as the Finnish government has been proposed some restrictions regarding the pricing of this kind of loan products. In government's proposal HE 78/2012 it is stated that unsecured loans with principal less than 2000 euros will get a rate-cap of 50% + reference rate (1% at 29.3.2013). The rate cap concerns the effective yearly

interest rate which includes both the interest rate and all other costs that follow the loan contract. This is quite remarkable change as now these effective yearly interest rates in the small loans are averaging in phenomenal 920 % (Statistics Finland).

This kind of product would partly fit quite well into the Jaffee & Russell –model. The product is very simple. There is one sum that is borrowed and it is paid back with certain interest rate factor. The loan contracts must be based on some simple estimation of the fraction of honest borrowers in the total population, because the lending decisions are made on very thin information. These are two period products and the possible risk will be realized to the lender in the second period. This part of the market is not near the non-rationing equilibrium because these loan products have very high interest attached to them. Further, they do demonstrate well that in the real credit market must be credit rationing and multiple equilibriums. The loan prices differs a lot in Finland and if we look all the consumer credit products it is easy to assume that on the high interest rates the defaults are also on high level. In the Finnish small loan markets lenders can face over 30 % defaults of the given loan contracts (Hörkkö 2010). It can be assumed that the high interest rate is ruling out big part of the honest borrowers and the costs of defaulting that kind of loan is not that big for the defaulters.

However, this loan product is not that interesting now when the new legislation is altering the market environment in the near future. Suomen pienlaina yhdistys Ry, which can be considered as the parent organization for small debt companies, published 28.3.2013 an announcement in which it states that the organization will close down after the new legislation will come into effect in June 2013. This will mean that this specific market will shrink substantially. It will be seen in the future how this effect the demand of other kind of consumer loan products. According to Statistics Finland the loan stock of small debts in Finland was 134 million euro in the end of 2012. The market's turnover in 2012 was 394 million euros. It is, however, relatively small compared to the whole consumer loan market as the small debt stock is less than two percent of the uncollateralized consumer loans.

5.1.2 Large consumer loans

According to my study the large consumer loans are usually based on an annuity calculation and it has a certain fixed monthly payment until the whole loan sum is paid. In this section I am presenting the basic characteristic of the consumption loans.

In the loan contract is stated following relevant variables for calculations:

1. the loan amount
2. starting time
3. running time (approximate)
4. monthly annuity payment sum
5. payment interval
6. loan costs
7. reference rate of interest
8. interest rate marginal

The loan amount is from 2000 to 50000 and an applicant can choose preferred sum from that range. However, the applicant must clear high enough credit score for each sum available. So, the higher sum applicant wants the better score he must have in the application phase.

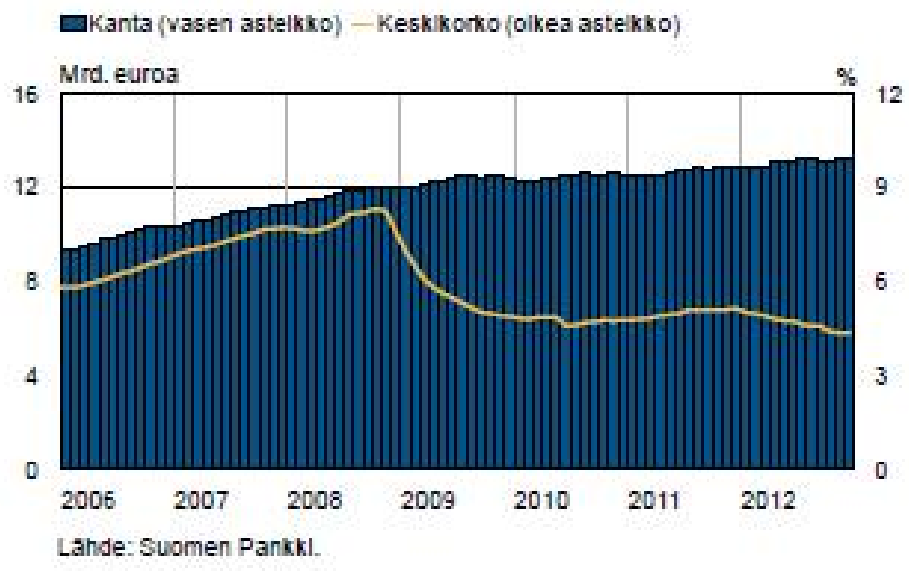
The starting point is the day when contract is made or the day when the money is wired to the borrower and from that day on the interest starts to accumulate. The payment interval is basically always one month. Each month borrower receives invoice that includes installment, monthly interest and monthly fee. The payment is calculated according to the annuity and the monthly sum is fixed for the whole running time. The loan interest is tied to a reference rate which is currently most often the 3 month euribor and the reference rate is updated once a year. The interest is calculated on a daily basis for the declining principle and invoiced every moth. This gives some unique characters for the running time. Because the interest rate is floating the running time is not known when the loan contract is made. This is due to the fact that while the monthly payment is fixed and the interest rate is floating the running time will rise if reference rate will grow. To make it simpler, when the interest rate increases a bigger proportion of the fixed monthly payment is used to cover the interest. This leads to smaller installments to the principal which in turn extends the running time. After each time the

interest has been updated the payment plan will be simulated to match the new interest rate and agreed annuity payment.

5.2 Market in Finland

According to the 'Annual Review 2012 of Financial Statistics In 2012' the Finnish consumer credit stock has grown 4 % to 13 billion euros in the banking sector. The growth has been slightly faster than the year before. About one third of these 13 billion were uncollateralized credit card loans or revolving loans and two thirds were fixed loans. 60 % out of these fixed loans were tied to collateral and 40 % were without collateral. This gives 4,3 billion markets for credit cards or similar products, 3,5 billion market for uncollateralized fixed loans and 5,2 billion markets for fixed loans carrying collateral.

Figure 9: The amount of household consumer credit and average interest rates over time. From Finlands Bank. Financial Statistics – Annual Review 2012



The average interest rate for credit card loans was a bit under 9%. In the fixed loans the average interest rate was 3,7 %. The difference might be due to fact that 60% of the fixed loans had collateral. The drop of market rates for money has not been channeled to consumers in the un-collateralized loan products as the banks have been raising marginal at the same time. The consumers have actually been facing similar rates than the year before.

As said before, the finance companies that operate only on market based money or some other types of financing are not under the bank surveillance. Approximately a bit over 10 % of total consumer loans were given by this kind of financing firms that do not hold banking license. More accurately at the end of 2012 the consumer credit portfolio of financing firms was 1,7 billion euros according Suomen Tilastokeskus. This will give us total 14,7 billion euros for the total consumer credit portfolio in Finland. No statistics were available about how this sum was divided between credit cards, fixed loans with collateral and fixed loans without collateral. If we assume that the shares are similar than with the banks the division would be 567 million in credit cards, 680 million in fixed loans with collateral and 453 million in fixed loans without collateral. This will leave us with total consumer credit stock that is divided as in Table 5: Credit cards or revolving loan 4,9 billion euro, fixed loan with collateral 5,9 billion euro and fixed loan without collateral 3,9 billion euro.

Table 5: Market size of the different loan types in Finland

Loan type	Banks	Finance companies *	Total
Credit card/ revolving loan	4333	567	4900
Fixed with collateral	5200	680	5880
Fixed with no collateral	3467	453	3920
Total	13000	1700	14700

unit = million

* division estimated to be similar to banks

5.3 Competition analysis

The Finnish loan markets consist of two kinds of lenders: banks and financing companies. I have gathered pricing information about lenders who give loans over 2000 euros. The pricing information is collected from websites of the lenders and there is a serious shortage in the information mainly considering banks but also the finance companies. Most of the banks do not give the pricing information in advance and the rates are tailored for each borrower. Reason for this might be that the Finnish bank industry is led by a few large banks. They have large customer base and they might limit the uncollateralized consumer loans mainly to their existing customers. Banks hold extensive information about their customers because they administer also the borrowers' bank accounts and are thus aware of the borrowers' economic situation.

Also most of the financing companies give the final rate after the application. However, the rate gaps (min – max) were informed by many of the players and they give interesting results. I also collected information about the costs lenders charge on top of the actual interest rate. As a conclusion it can be said that the price differences seem very large and the pricing in itself is made hard to understand. The comparison between loans is difficult and it is apparent that market works through price differentiation depending on loan sums and/or risk predictions. The comparison could be made optimally with the effective annual interest rate that considers also all the loan costs but this information was not available for fixed loan sums. Thus, I present the rate gaps the lenders are informing.

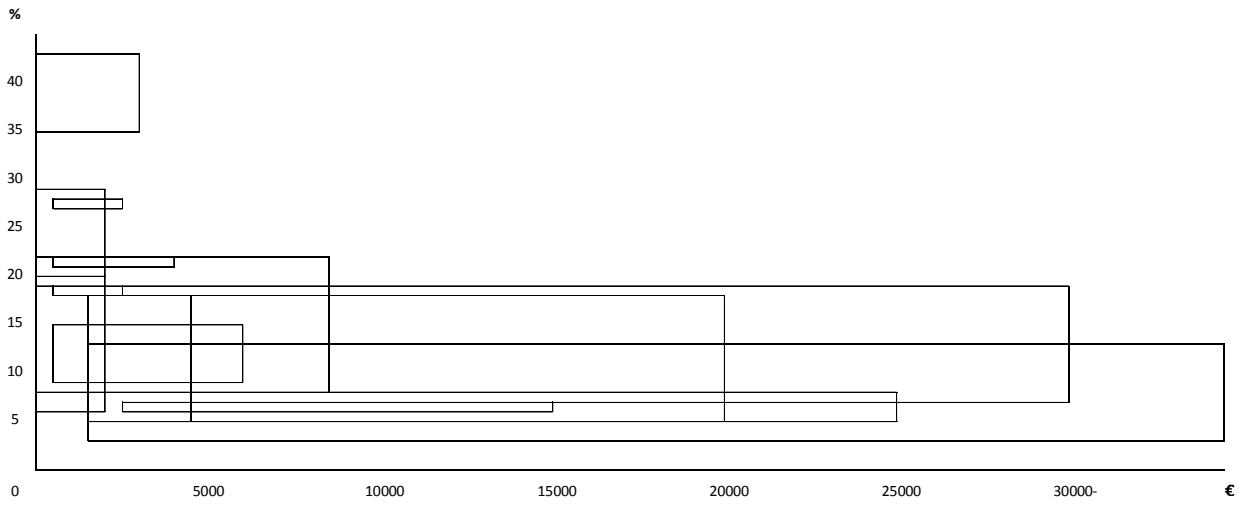
Table 6 is showing the pricing information of the lenders that offer uncollateralized consumer loan over 2000 euros. On the market there are currently 17 lenders of which 8 are banks and 9 are financing companies. Most of the lenders give the actual rate only after the loan is approved. The loan sums start from 2000 and are at highest 50000 euros. Announced lending rates are ranging from 4% to 43%. The fees have also large variation as opening fees vary from 0 to 450 euros and monthly fees from 0 to 25 euros.

Table 6: Comparison of Finnish lenders

Company		Loan sum	Interest rate	Opening fee	Monthly fee
Tapiola	Bank	?	?	?	?
Danske	Bank	?	?	?	?
Santander	Finance	2000 - 50000	4 - 13 %	149	8
Nordax	Bank	3000 - 30000	8 - 19 %	?	?
Nordea	Bank	2000 - 25000	6 - 8 %	175	4,5
S-pankki	Bank	5000 - 20000	6 - 18 %	100	7
Handels Banken	Bank	2000 - 20000	5 %	100	5
OP	Bank	3000 - 15000	7%	120	3
Bigbank	Bank	500 - 10000	9 % -	95-195	8
Svea	Finance	200 - 8500	9 - 22 %	135	9
LHV	Finance	1000 - 6000	10 - 15 %	199	9
Joustolaina	Finance	1000 - 4000	22 %	60	5
Credit 24	Finance	50 - 3000	36 - 43 %	?	?
Ellos	Finance	100 - 2500	28 %	0	0
Ostosraha	Finance	100 - 2500	19 %	?	5
Euroloan	Finance	50 - 2000	7 - 29 %	0-450	0-24.5
Laina.fi	Finance	50 - 2000	20 %	?	?

One can hardly say that this market has found an equilibrium point, but it seems that companies who offer larger loans also give cheaper prices for the loans. This could actually support the assumption that the higher loan sums are priced lower than smaller loans. If we look at the companies who offer loans of over 10000 euros we can see that the lower rate boundary is between 4 % and 9 %. The higher boundary for interest rates is between 13 % and 19 % (excluding OP who is giving a constant rate for all loans). That way the difference is not that big if we assume that lower rate goes for the biggest loans. The difference in the boundaries can be explained by the risk based pricing between those limits or the lender's competence in risk identification. The lenders are supposed to optimize their prices to match the level of risk identification they possess. For the smaller loans the market is moving towards the small loan market where the risks and prices are getting higher. The opening fees do not seem to have any clear pattern against loan sum.

Figure 11: The supply in Finnish market



In the Figure 11 I have illustrated the interest rate spreads and offered loan sums. The figure does not show the effect of different fees, but the small loans carry relatively more fees than the larger sums. The boxes in the picture present different lenders and show the loan sum and interest rate area they operate. We do not know the actual rates for different loan sums, but it seems clear that lenders who offer only small loans have higher interest rates than those who

offer higher loan sums. As the loan sums grow the rates seems to go down. Between the extreme parts of the supply space the difference is clear. However, in the middle range the difference is not that evident. It is not clear whether the interest rate is affected by the loan sum or the risk evaluation. Some of the lenders informed different prices for different sums. For example S-Pankki and Santander informed following interest rates according to the loan sum:

S-pankki			
Sum	5000-10000	10000-15000	15000-20000
Rate	8 %	7 %	6 %

Santander				
Sum	2000-5000	5000-20000	20000-40000	40000-50000
Rate	13 %	10 %	8 %	4 %

On the other hand Nordea informed that the rate is dependent on the customer rating level (normal customer, regular customer or key customer) and the spread was from 6 % to 8%. Most of the other lenders inform that loan contract is personalized for all individual borrowers. It seems that banks are offering lower rates than finance companies and that would refer to better knowledge about their customers.

If we look the situation in the RL-space the lenders are having different supply curves and they are optimizing the prices by risk detection power. Different lenders are choosing to operate on different risk levels depending on their investments on the risk detection (credit scoring or information sharing). Those who have good scoring systems can offer better loan contracts for the customers. Recall that in the RL-space this will bend the lenders supply curve downwards and they can offer better price for given loan sum. This will also diminish the risk of moral hazard because while the price gets lower the borrower's default cost stays the same.

The interest rate spread in the consumer loan market can be interpreted so that while in the Jaffee & Russell –model lenders optimized loan contracts over the loan sum L and interest rate R, the risk identification factor X that was presented in the chapter 5.4.3 must also be taken into account. If all lenders would have the same recourses the markets would run prices on equilibrium points depending on the loan sums. In reality resources are different. Lenders have

limited budgets and knowledge so they have to choose the market they are operating. Some amount of uncertainty must be accepted but lenders can smooth the information asymmetry by investing in information tools.

We can compare the market situation to Jaffee & Russell -model and assume that there is a theoretical equilibrium rate for given loan sum. The lender can escape from it only by changing the default risk measure. If he is raising the price he must accept the increase in the risk. The price reduction, on the other hand, is sensible only if the lender can make better credit decisions and this requires investments in information. At the same time, the borrower is trying to get the loan for the best price available but he must settle for the price he is getting according to his risk signal. For an honest borrower who can signal his type to the lender this gives advantage. He can get a lower price when lender's scoring system is working properly.

In the Jaffee & Russell -model the supply curve was presented upward sloping or backward bending. At the same time the market situation seems to suggest that the supply curve is actually downward sloping. The reason might be that lenders are discriminating prices for different loan sums. They are offering rates that are near the demand curve. Some lenders have made the pricing very complex which can decrease the adverse selection. If pricing would be clear the honest borrowers who get good credit rating would choose the cheapest loan. Lenders with higher prices would then have only those customers others will reject. On the other hand, if prices cannot be detected also the lenders with high prices might get better customer portfolio.

In this kind of fragmented market where pricing is complex and comparison between lenders is difficult the single market equilibrium does not seem to exist. There must be multiple equilibrium points according to loan sum. I have studied mainly the informational asymmetries that lenders are facing but it seems evident that also the borrowers are facing informational challenges. When prices are made hard to compare the borrower will optimize a loan contract by price and the effort he will put to comparison. The Jaffee & Russell -model seems a logical frame to get familiar with the basic dynamics in lab setting, but in the real market the model faces difficulties to explain different risk levels and equilibriums.

6 Conclusions

In this study I have presented the basic setting of the consumer credit market. The theoretical model was the Jaffee & Russell –model from 1976. The literature from relevant field backs up the basic characteristics of the model. However, it was seen that the model is a simplistic representation of the actual market. It is most suitable for a market where lenders do not demand collaterals against the loan and the loan products are simple. The model assumes only two periods which is not the case in the Finnish consumer credit market. The loan contracts are based on multiple periods and annuity schedules which give restrictions on the analysis based on the model. Still the Jaffee & Russell –model is simple and good tool for making assumptions about market equilibriums, while the analyses must be taken cautiously.

I showed that lenders have to work with the asymmetric information and make pricing decisions regarding it. A lender cannot know for certain if the borrower will pay back the loan and this will pull the prices up. If the lenders have limited information about borrowers the honest borrowers have to pay higher prices and so compensate the defaults dishonest borrowers accumulate to lenders. However, lenders can improve their knowledge about borrowers and the default risk they carry. This can be done by information sharing platforms and automated credit scoring. The information sharing platforms are used to share knowledge that different lenders have about individual borrowers. It has been shown in the previous research that information sharing benefits the market as a whole. The credit scoring models are used to handle more effectively the available information that a lender possess. These models can give competitive advantage for a lender if the default probability is identified more accurately than in the market on average. Despite of this, a lender has to be careful with the pricing and credit decisions. Wrong kind of pricing in the market might attract dishonest people and run the defaults up. To capture the effect that information sharing and credit scoring has on the supply I inserted into the model a variable that depicts the amount of information. The investment on information raises the lender's cost but at the same time it enhances the quality of the loan portfolio and decreases the defaults. As a lender learns to identify good borrowers he can get more volume by giving higher loan sums, extract profits above his supply curve or

price the loan under the market price. If a lender can offer better contract to borrowers it will decrease adverse selection and moral hazard.

The analysis of Finnish consumer credit market showed somewhat different story than the general Jaffee & Russell –model. The pricing in the market seems to be very complex. Some lenders inform that they price the loan regarding the loan sum and others give price according to borrower's application or mixture of these two variables. A declining supply function can be spotted depending on the loan sum but it seems evident that prices can differ relatively much within the same loan size. This can be explained by two factors. First, the complex pricing can make it hard for borrower to detect the cheapest loan. Second, the lenders are offering personalized rates depending on the assumed default risk of a borrower. It can be argued that lenders are discriminating the prices. They optimize the profits by choosing whether they want to operate with relatively honest people and invest on risk detection or accept the high risk and keep the prices high and loan sums low. If lender can make good credit decision he can introduce competitive pricing.

The Jaffee & Russell –model is a good framework to get familiar with concepts of adverse selection and moral hazard. However, for further study I would recommend to develop it. I introduced how different individual risk identification abilities can be taken into account. This is a good starting point but also the effect of complex pricing and multiple equilibriums require further studying.

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