CALCULATION OF THE RISK PREMIUM IN A SELF-SUSTAINING, INCOME-CONTINGENT STUDENT LOAN SYSTEM

Edina Berlinger PhD.
Tamás Makara PhD.
Department of Finance
Budapest University of Economic Sciences and Public Affaires
H-1093 Budapest, Fővám tér 8., Hungary
E-mail: edina.berlinger@bkae.hu
t.makara@alarmix.net

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ABSTRACT

In order to maintain the financial stability of the zero-profit student loan system continuous control and periodical intervention is inevitable. In this article we focus on the problem of the calculation of the risk premium, which assure the self-sustaining operation, when the repayment rate is given. We introduce a so called "top-down" simulation technique to create individual income paths which is quite simple to use and fits well the available cross-sectional database. We conclude that in a society where individuals income relative to others can easily change in time the risk premium of the student loans can be much lower.

SELF-SUSTAINING, INCOME-CONTINGENT STUDENT LOAN SYSTEM

In 2001 a new institution was implemented in Hungary whose aim is to provide loans to the students of higher education. The repayment is income contingent (ICL-scheme), conditions (e.g. eligibility, interest rate, repayment rate, maximum allowance per month) are the same for everybody and it is declared that the system must operate in a self-sustaining (zero-profit) way, which means that the default risks and operating costs should be financed by the risk cohort of the debtors so in principle it must work without any direct state subsidy. Almost every student borrows up to the maximum possible amount of the loan, which is administered on individual accounts and the actual interest rate starts to accumulate. The repayment period begins just after graduation. There is always one interest rate and repayment rate valid for everybody but these parameters can be changed year to year. The income-contingent repayment lasts until full repayment or retirement (in case of early death or disability debt is cancelled).

Until now the Student loan Centre Plc. made over 170 000 contracts and granted loans of over 70 billion HUF. Estimations show that the mature system (in 20-25 years) can be compared to the biggest retail banks in Hungary considering number of clients and aggregate loan stock.

The origin of this Hungarian model goes back to Milton Friedman who was the first to introduce the idea of a self-sustaining, income contingent student loan system (Friedman 1962). Several authors joined to this thought (Cohn and Geske 1996]) but it was tested in practice only in the 70's in the United States when some universities (Duke, Yale, Harvard etc.) set up income-contingent plans. The most famous example is the TPO-plan at Yale University designed by James Tobin. In this special model one had to pay a fixed percent of her/his income until the whole debt of the cohort was repaid. Later, differences in income led to such a cross-financing effect that wasn't acceptable any more, so in 1999 debts were cancelled and the system was abolished. The failure of Tobin's model contributes to the belief that an income-contingent student loan system cannot work in a self-sustaining manner.

The first national ICL system was created by the Australian government in 1989, New Zealand and Great-Britain followed suit in 1992 and 1996 (Chapman 2002; Barr 2001). These student loan systems are considered fundamentally successful, but the plans are considerably subsidised (interest rates are often lower than corresponding treasury bond yields), not surprisingly they go along with huge government-expenditure. Another difference relative to the Tobin's model is that debt is registered on individual, rather than cohort level, so cross financing cannot be so high.

If the Hungarian model proves to be sustainable it can serve as an example for other developing countries or countries in transition whose governments cannot increase significantly the budget deficit.

MICROSIMULATION OF INDIVIDUAL INCOME PATHS – A TOP-DOWN MODEL

The field of dynamic micro simulation originates from a paper by Orcutt (Orcutt 1957). He suggested the development of simulation models using micro-agents for policy use. In recent decades with the development

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of information technology micro simulation models were elaborated in a lot of countries (USA, Canada, UK, France, Australia) for several purposes (i.e. analysis of redistribution effect of the tax system, pension and health care systems, financing of education etc.) (Harding 1996).

In these models hundreds of stochastic equations and deterministic algorithms are used to represent complex life events. Events are mainly represented by transition matrices or multi-nominal logit relations which are supposed to be dependent on the actual status of the individual or in the simpler models are constant over time. Events influencing job history and income path can be: carrier effect, job change, unemployment, disability, geographical mobility etc. Wage equations can include age, race, sex, education, experience, marital status as explanatory variables with the residual randomized to create some earnings mobility. These residuals represent nonsystematic effects and are independent from one individual to another.

The main advantage of this kind of modeling is that it allows to capture the full distributional impact of some policies, whose full effects take a considerable amount of time to filter through. However model building requires enormous computing, data and manpower resources. Another problem is that greater complexity increases the risk that the model functions as a 'black box' and the validation of the model also requires special considerations.

In the case of student loaning it is quite straightforward that we should use micro simulation techniques. *First,* if everybody would be exactly like a representative agent, there would be no problem at all. Every time we use averages and not the whole distribution of income we under- or overestimate the risk-premium needed to self-sustaining operation. *Second,* the task is relatively simple: we have to simulate the basis of the repayment: the official yearly gross income. We do not have to take into consideration black revenues or the effects of taxes or social insurance. Third, according to the government decree, the Hungarian Student Loan Centre Plc. is annually obliged to calculate the zero-profit risk premium, so it's worth to make an effort to construct a complex model. And *finally*, after some decades of operation the student loan company will have all the representative panel data on the income of graduates.

Actually we face some fundamental problems:

- We do not have enough data to evaluate regression equations yet.
- In our economy in transition we do not know how the present relations and relevant macroeconomic factors can evolve in a medium or a long time.

We were searching for a micro simulation model which doesn't need a huge and detailed database but captures the relevant characteristics of the income paths of individuals and can be calibrated to some available cross-sectional information about current income-distribution.

The main characteristics of income paths in reality are:

- High diversity.
- Positive trend (nominal decreasing is less probable than increasing).
- Positive autocorrelation along the income path.
- Special carrier pattern (income increase more in the first years than later).
- Lognormal-nature of cross-sectional income distribution.

The available database, we had:
Survey on graduates' income in 2001. From OMMK (National Labour Centre).

The steps of the simulation:

Simulating Income Paths (using Mathematica)

1. We simulate only one generation, because we do not want to allow for intergenerational redistribution. It means that in theory every generation should operate in a self-sustaining manner.

2. The simulation operates in discrete time. One period is one year.

3. The t=0 point represents the minute just after graduation. At the end of the first year every debtor is 23 years old. The model covers N=39 years until the retirement age (62 years).

4. At the beginning of the repayment period the generation consists of Q_0=10 000 individuals, who have the same amount of debt: H_0=2.4 millions of HUF.

5. Every year, d percent of the debtors disappears definitely (died, disabled, emigrated etc.). Their total debt is cancelled. While probability of death and disability can be known precisely, other types of disappearance are rather difficult to estemate and they have much larger effect. Taking d constant the number of the debtors in the cohort in the t-th year (Q_t) equals:

   $$Q_t = Q_0 \cdot (1-d)^t$$

   We used d=1%.

6. Those who have not disappeared can be inactive, unemployed or working. It is only w=80% of the remaining population who work.

7. Inactive and unemployed debtors always have to pay α=6% of the official minimum wage

(M_t, which is currently M_0=53·12=636 thousands of HUF per year). The minimum wage is assumed to increase by a=1,071 year by year just like the average nominal income of all employees. (Which comes from 5% inflation and 2% real income growth.)

$$M_t = M_0 \cdot a^t$$

8. We suppose that the aggregate cross-sectional distributions of income above the actual minimum wage (M_t) follow lognormal distribution with mean μ_t and standard deviation σ_t .

9. We estimated average carrier growth factors of the t-th year (c_t) emanating exclusively from the advancement of the carrier (promotion or job change) using the OMMK cross-sectional database. The standard deviations were estimated the same way. We supposed a steady-state world in the sense that we assumed that the carrier path remains the same.

10. The essential point of our model is that the t-th year's gross income of the i-th individual is determined by his income rank, $k_{i,t}$, which is a natural number between 1 and Q_t. The individual with income rank 1 has the lowest income of the population and the individual with income rank Q_t has the highest income. The 20 percent of the population with the lowest income ranks are inactive or unemployed and they earn the minimum wage, M_t. The t-th year's gross income of the individuals who work is determined by the following function (l):

$$B_{i,t} = \begin{cases} M_t, & k_{i,t} \le (1-w)Q_t \\ M_t + l(k_{i,t}, q_t, \mu_t - M_t, \sigma_t), & k_{i,t} > (1-w)Q_t \end{cases}$$

$$i=1,2....q_t$$

where l represents the discretisation of the lognormal distribution with mean $\mu_t - M_t$ and standard deviation σ_t and $q_t = wQ_t$, the number of people who work.

11. The mean income of the working population in the t-th year (μ_t) is determined as follows:

$$\mu_t = \mu_0 \cdot \prod_{j=1}^{t} a \cdot c_j$$

and μ_0 (the mean of the average income above the minimum wage at time t=0) is 110-53)·12=57·12= 684 thousands of HUF.

12. In the t-th year, the k_i rankings come from a special stochastic "reshuffling" process. It is quite probable that the ranking of a given individual changes a little bit every year, but there is little chance to have a big jump. We use two kinds of normally distributed random numbers: one for the noise around the latest ranking, and another for the big jumps that represent significant changes in the individuals carrier or social status. We use a Bernoulli random number for signaling if there is jump or not. Adjusting the parameters of the random numbers' distributions we can achieve high or low variation of rankings and so we can analyse the effects of the income-variability.

This model can easily be generalized by using parameters depending on time, age, sex, industry etc. One can replace the lognormal distribution with another – empirical or hypothetic – distribution. It seems however that already in this simplicist form, this model is able to catch all the main caracteristics of income paths mentioned above. In a few years we will have enough data to further refine the parameters and to bring the model to the real world phenomena. Figure 1. and Figure 2. shows some income paths given by the model in four special cases.

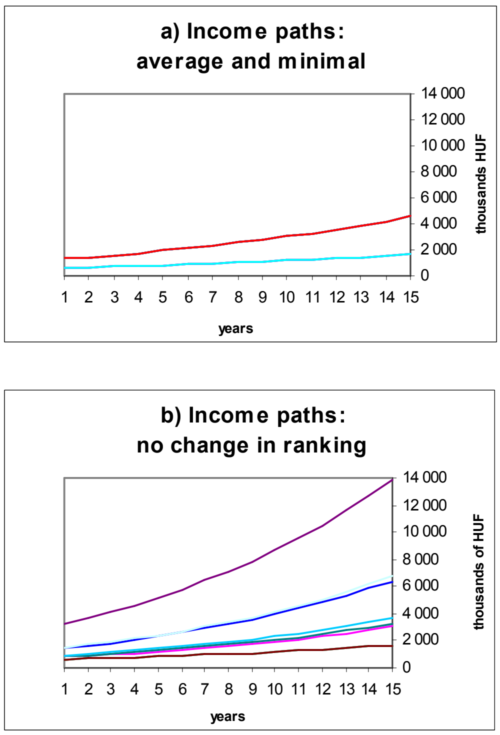
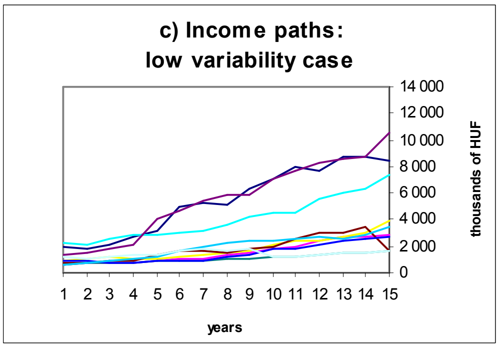


Figure 1: Income paths without reshuffling



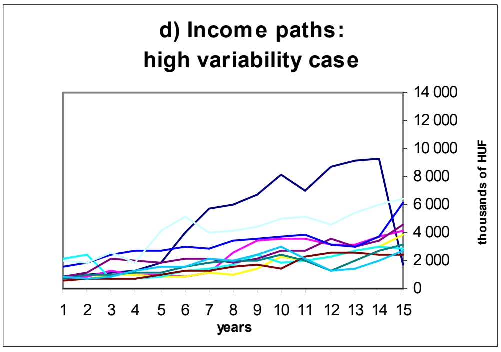


Figure 2: Income paths with reshuffling

Case a): The official risk premium calculation takes the assumption, that there is only two status of every debtor still in the cohort: average wage and minimal wage.
Case b).: We introduce the lognormal distribution of incomes, but still disregard the "reshuffling" effect: everybody preserves her/his initial ranking.
Case c): Lognormal distribution with light "reshuffling" effect.
Case d): Lognormal distribution with strong "reshuffling" effect.

The logic of this and the traditional income simulation are quite different. We accepted the available cross-sectional income distribution relevant and stable but we did not examine what forces had created it. This is why we call this model "top-down": we start with the aggregate relationship and force individuals to match it. In traditional microsimulations the distribution of incomes is only the result of the complicated correlations estimated from long panel data ("bottom-up"). In traditional microsimulations individuals have independent noises in their incomes, here ranking is noisy as well, but a kind of interdependence still exist.

The Calculation of the Risk Premium

We had 10 000 income paths in each of the four cases. Keeping these income paths fixed we examined the effect of possible risk premiums on the net profit/loss of the Student Loan Company. Profits or losses are expressed in HUF and in present value. (The present value of the whole debt is $Q_0 \cdot H_0 = 24$ billions of HUF.)

1. Calculating individual debts year by year ($H_{i,t}$) along every income path.

$$H_{i,t} = \max\left(r \cdot H_{t,t-1} - \alpha \cdot B_{i,t}; 0\right)$$

where r is the interest factor of the student loan, which consists of two elements: factor of the cost of financing (f) and risk premium (p): $r = f + p$. We assumed f=1,071.

2. Calculating individual repayment cash-flows ($C_{i,t}$) along every income paths.

$$C_{i,t} = \min\left(r \cdot H_{i,t-1}; \alpha \cdot B_{i,t}\right)$$

3. Calculating aggregate profit/loss of the lender (π):

$$\pi = \sum_{i=1}^{Q_0} \sum_{t=1}^{N} C_{i,t} \cdot f^{-t} - H_0 \cdot Q_0$$

Results are summarized in the Figure 3.

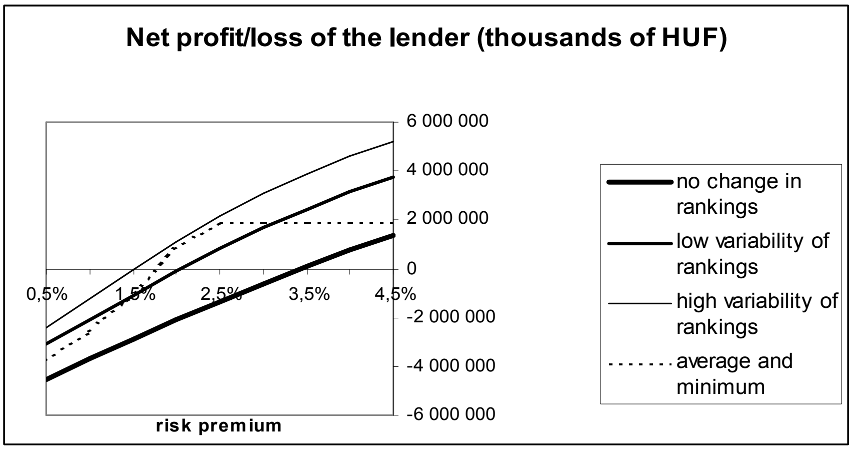


Figure 3: Net profit/loss of the lender

The lender wants to operate on zero-profit level, thus we can numerically determine the risk premium where profit is just zero. Table 1. shows zero-profit risk premia in cases a)-b)-c)-d).

Table 1: Zero-profit risk premia

average and minimal	1,79%
no change in ranking	3,44%
low variability case	2,07%
high variability case	1,51%

It is interesting that taking income distribution without "reshuffling" effect causes as high risk premium as 3,44%. Inserting the "reshuffling" effect will reduce the risk premium to 2,07% and 1,51% depending on the variability. We can summarize that from the point of view of the lender the most favorable situation is when the standard deviation of the cross-sectional income distribution is low, but the reshuffling of rankings is high. We can draw another conclusion as well: as current practice disregards both the cross-sectional standard deviation and the reshuffling of rankings it can happen that the two effects roughly compensate for each other and the official estimate of the risk premium is quite accurate.

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