THE COST OF A UNIVERSITY DEGREE BEFORE/AFTER DEREGULATION

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1. Introduction

There has been much speculation concerning the effects of the recently proposed Abbott administration budget on the cost of a university education. The purpose of this model is to shift discussion away from speculation toward concrete figures. It is of course impossible to predict the precise cost of a university degree under the proposed deregulated system as this depends upon many unknown variables. Nevertheless, once one chooses values for these variables as our webpage allows, one can easily calculate the total cost of a degree using information that the government has provided and several well-defined assumptions. In this article, we explain in simple terms how our model computes this total cost. The reader can also download the source code of the model from [1] to see how the computation is implemented in javascript.

This model compares the total cost of a university degree for a student beginning university in 2014 under the current system and the proposed system.[1] The underlying assumptions in this model are that the student takes out a HECS-HELP loan to pay the entirety of his/her student fees, and that the student pays back the loan at the minimum repayment rates as specified in [2] and [3]. We also assume that annual tuition fees increase at the rate of inflation and that the threshold incomes for each repayment rate increase at the rate of inflation. The starting salary is also adjusted with inflation but the percentage that the salary increases each year is not adjusted with inflation.

The resulting figures represent the cost of a degree in today's dollars. This means that dollar sums for loan payments in future years are readjusted with inflation so that they make sense in 2014 dollars. For instance, if the inflation rate is 2%, a loan payment of \$1000 in the year 2024 translates to $\$1000(1.02)^{-10}$ or \$820.34 in today's dollars.

2. Variables

In our model, the user chooses values for each of the following variables:

$$\begin{aligned} \texttt{N} &= \text{ number of years taken to finish degree} \\ \texttt{NEW\_TUITION} &= \text{ domestic annual tuition fees in unregulated system} \end{aligned}$$

[1]The proposed changes wouldn't take affect to 2016 but for the sake of comparison, it is useful to compare the costs in the same year.

$$
\begin{aligned}
\texttt{INF} &= \text{inflation rate}\\
\texttt{BOND} &= \text{ten-year treasury bond rate}\\
\texttt{GAP} &= \text{number of years after graduation before earning the specified starting salary}\\
\texttt{SALARY} &= \text{starting salary in today's dollars}\\
\texttt{RAISE} &= \text{annual salary increase as a percentage in real dollars}^{2}
\end{aligned}
$$

3. Current system

In this section, we explain how our model computes the total cost of an education under the current regulated system. For this calculation, the variable TUITION denotes the current domestic tuition fees for one year. These fees depend on the subject the student chooses to study. Explicitly, using the figures from [4],

$$
\texttt{TUITION} = \begin{cases}
\$10085 & \text{for Accounting}\\
\$10085 & \text{for Admnistration}\\
\$6044 & \text{for Behavioural Science}\\
\$10085 & \text{for Commerce}\\
\$8613 & \text{for Computing}\\
\$10085 & \text{for Economics}\\
\$8613 & \text{for Engineering}\\
\$6044 & \text{for Foreign Languages}\\
\$6044 & \text{for Humanities}\\
\$10085 & \text{for Law}\\
\$8613 & \text{for Mathematics}\\
\$8613 & \text{for Science}\\
\$6044 & \text{for Social Studies}\\
\$8613 & \text{for Statistics}\\
\$6044 & \text{for Visual and Performing Arts.}
\end{cases}
$$

In the current system, there is no interest applied to the loan in terms of today's dollars. Therefore, the total cost of the education is simply

$$\texttt{N} * \texttt{TUITION}$$

where N is the number of years taken to complete the degree.

Next we explain how our model computes the number of years needed to pay off the loan. We break up the calculation into three periods of time: (1) University years (2) Gap years and (3) Professional years.

[2] The choice to use real dollars rather than today's dollars to specify the annual rate that salary increases is due to the fact that raises are generally considered in these terms.

3.1. **University years.** In our model, the tuition fees increase with inflation. In the first year, the student takes out a loan for $\mathtt{TUITION}$. Let us use the variable $\mathtt{DEBT_i}$ indexed by an integer $\mathtt{i}$ to represent the student's debt in the year $2014 + \mathtt{i}$.[3] The number $\mathtt{DEBT_i}$ will represent the debt in real dollars (i.e., in the actual dollars in the year $2014+\mathtt{i}$). Note that $\mathtt{i} = 0$ corresponds to the first year of university in 2014.

After the first year ($\mathtt{i} = 0$) of university,

$$\mathtt{DEBT}_0 = \mathtt{TUITION}.$$

Now after the second year ($\mathtt{i} = 1$), the annual tuition becomes $\mathtt{TUITION} * (1 + \mathtt{INF})$. During the second year, the previous debt is indexed by inflation. Therefore, after the second year, the debt becomes

$$\mathtt{DEBT}_1 = (1 + \mathtt{INF}) * \mathtt{DEBT}_0 + (1 + \mathtt{INF}) * \mathtt{TUITION}.$$

Since the previous debt $\mathtt{DEBT}_0$ is simply $\mathtt{TUITION}$, we can write the debt after the second year as

$$\mathtt{DEBT}_1 = (1 + \mathtt{INF}) * 2 * \mathtt{TUITION}.$$

Similarly, in the third year ($\mathtt{i} = 2$), the annual tuition becomes $\mathtt{TUITION} * (1 + \mathtt{INF})^2$ and the debt $\mathtt{DEBT}_1$ is indexed by inflation. Therefore

$$\begin{aligned} \mathtt{DEBT}_2 &= (1 + \mathtt{INF}) * \mathtt{DEBT}_1 + (1 + \mathtt{INF})^2 * \mathtt{TUITION} \\ &= (1 + \mathtt{INF})^2 * 3 * \mathtt{TUITION}. \end{aligned}$$

If the student graduates after three years (i.e., $\mathtt{N} = 3$), we have computed the total debt the student graduates with. Otherwise, the debt is calculated similarly for the fourth year, and so on until the student graduates after $\mathtt{N}$ years. Explicitly, when the student graduates after $\mathtt{N}$ years ($\mathtt{i} = \mathtt{N} - 1$) of studying in the year $2014 + \mathtt{N} - 1$, the student's debt is

$$\mathtt{DEBT}_{\mathtt{N}-1} = (1 + \mathtt{INF})^{\mathtt{N}-1} * \mathtt{N} * \mathtt{TUITION}.$$

Recall that this number reflects what the student owes in terms of dollars valued in the year $2014 + \mathtt{N} - 1$. Of course, in terms of today's dollars, the student owes simply $\mathtt{N} * \mathtt{TUITION}$.

[3] In this article, the year $2014 + \mathtt{i}$ should be interpreted as the financial year $2013 + \mathtt{i}/2014 + \mathtt{i}$. Debts are indexed at near the end of the financial year (precisely, they are indexed on 1 June of $2014 + \mathtt{i}$). In this model, the student begins university in the first academic semester of 2014 (i.e., in February 2014). In the current HECS-HELP system (as well as the proposed system), only the fraction of the debt that has been outstanding for 11 months or more is indexed. Therefore, the debt generated from the loan necessary to pay both the first semester and second semester tuition fees of $2014 + \mathtt{i}$ is first indexed on 1 June $2014 + \mathtt{i} + 1$.

3.2. **Gap years.** After the student graduates, the student doesn't begin earning the specified starting salary $\mathtt{SALARY}$ until $\mathtt{GAP}$ years elapse. During this time, the debt is indexed with inflation. This means, in the year $2014 + \mathtt{N} + \mathtt{GAP} - 1$, the student's total debt has now accumulated to

$$\begin{aligned}\mathtt{DEBT}_{\mathtt{N+GAP}-1} &= (1 + \mathtt{INF})^{\mathtt{GAP}} * \mathtt{DEBT}_{\mathtt{N}-1} \\ &= (1 + \mathtt{INF})^{\mathtt{N+GAP}-1} * \mathtt{N} * \mathtt{TUITION}\end{aligned}$$

in terms of dollars in the year $2014 + \mathtt{N} + \mathtt{GAP} - 1$ (again in today's dollars, the debt is still $\mathtt{N} * \mathtt{TUITION}$).

3.3. **Professional years.** After the university years and the gap years, the student (now a professional) begins earning the specified starting salary. Precisely, in the year $2014 + \mathtt{N} + \mathtt{GAP}$, the salary in real dollars is $\mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}}$ dollars per year. In this first year earning a salary, the debt is first indexed by inflation so that the new debt (before paying anything off) becomes

$$(1 + \mathtt{INF}) * \mathtt{DEBT}_{\mathtt{N+GAP}-1}.$$

The student is then responsible for paying back a percentage of the salary toward the loan. This percentage is determined by the HECS-HELP minimum repayment rates [2] which depend on the student's income adjusted for inflation.

Let us temporarily denote $\mathtt{X}$ as the salary in today's dollars (i.e., $\mathtt{X} = \mathtt{SALARY}$). Then the repayment rate is:

$$\mathtt{REPAY\_RATE} = \begin{cases} 0\% & \text{if } \mathtt{X} < 51309 \\ 4\% & \text{if } 51309 \le \mathtt{X} < 57153 \\ 4.5\% & \text{if } 57143 \le \mathtt{X} < 62997 \\ 5\% & \text{if } 62997 \le \mathtt{X} < 66308 \\ 5.5\% & \text{if } 66308 \le \mathtt{X} < 71277 \\ 6\% & \text{if } 71277 \le \mathtt{X} < 77194 \\ 6.5\% & \text{if } 77194 \le \mathtt{X} < 81256 \\ 7\% & \text{if } 81256 \le \mathtt{X} < 89421 \\ 7.5\% & \text{if } 89421 \le \mathtt{X} < 95287 \\ 8\% & \text{if } 95287 \le \mathtt{X}. \end{cases} \tag{1}$$

In the first year after earning this salary, the student pays

$$\mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}} * \mathtt{REPAY\_RATE}$$

in real dollars toward the debt. Therefore, after the first year earning this salary, the debt becomes

$$\mathtt{DEBT}_{\mathtt{N+GAP}} = (1 + \mathtt{INF}) * \mathtt{DEBT}_{\mathtt{N+GAP}-1} - \mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}} * \mathtt{REPAY\_RATE}.$$

In each subsequent year, the salary increases by $\mathtt{RAISE}$ percent in real dollars. In the year $2014 + \mathtt{N} + \mathtt{GAP} + \mathtt{i}$, the salary in real dollars is

$$\mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}} * (1 + \mathtt{RAISE})^{\mathtt{i}}. \tag{2}$$

Let us again denote by $\mathtt{X}$ the new salary in today's dollars. Taking into account inflation, we have

$$\mathtt{X} = \mathtt{SALARY} * (1 + \mathtt{INF})^{-\mathtt{i}} * (1 + \mathtt{RAISE})^{\mathtt{i}}.$$

In the year $2014 + \mathtt{N} + \mathtt{GAP} + \mathtt{i}$, the debt is first indexed by inflation and then the student then pays REPAY_RATE percent of his salary in real dollars (as computed in (2)). Here the repayment rate REPAY_RATE is provided by formula (1) which depends on $\mathtt{X}$. Therefore, at the end of the year $2014 + \mathtt{N} + \mathtt{GAP} + \mathtt{i}$, the debt is

$$\begin{aligned}\mathtt{DEBT}_{\mathtt{N+GAP+i}} = &(1 + \mathtt{INF}) * \mathtt{DEBT}_{\mathtt{N+GAP+i-1}} - \\ &\mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}} * (1 + \mathtt{RAISE})^{\mathtt{i}} * \mathtt{REPAY\_RATE}.\end{aligned}$$

This continues until the total debt has been paid offer. Let $\mathtt{M}$ be the value of $\mathtt{i}$ when the total debt has been paid off.[4]

Remember that we already know that the total cost of the education is $\mathtt{N} * \mathtt{TUITION}$. We've now computed that $\mathtt{GAP} + \mathtt{M}$ represents the number of years after graduation that it takes to pay off the debt.

4. Deregulated system

We now explain how our model computes the total cost of an education under the deregulated system proposed by the Abbott administration. In our model, the user enters the value for the variable NEW_TUITION which reflects the domestic tuition rates under the deregulated system.

We break up the calculation into three periods of time: (1) University years (2) Gap years and (3) Professional years. During the university years, the student takes out a loan to cover the tuition costs and interest accumulates on this loan. During the gap years, interest accumulates. Finally during the professional years, interest continues to accumulate while the student pays off the debt.[5]

[4]It is possible that the debt is not fully paid off before retirement. Our model assumes that the student stops working 50 years after graduation.

[5] From currently available government sources, it is unclear whether interest under the proposed system is to be compounded annually or compounded continuously. We sought a clarification from the government on this matter and received the following response via email from the Quality and Student Support Group within the Department of Education:

> Indexation is applied to HELP debts on 1 June each year. The amount that is indexed is the portion of the debt that has been outstanding for 11 months or more - it is 11 months from the date the debt is incurred, not the date the person finishes their studies). Therefore, indexation commences whilst the person is still studying, and continues to be applied each year on 1 June until the person has repaid their debt. It 'compounds' each year, in the sense that the indexation applied in one year forms part of the amount that is indexed in the following year. In respect of HELP indexation, all the Government is doing is changing the rate. As you are aware, all HELP debts are currently indexed using the Consumer Price Index. From 1 June 2016 all HELP debts will be indexed using the 10 year Government Bond Rate (capped at 6 per cent).

Therefore, in our model, we compound the interest annually.

4.1. **University years.** Throughout the discussion below, the variable $\mathtt{DEBT_i}$ will represent the total debt of the student in real dollars at the end of the year $2014 + \mathtt{i}$ (i.e., the actual amount of dollars the student will owe at the end of that year).

The student's tuition is $\mathtt{NEW\_TUITION}$ for this first year at university. After the first year ($\mathtt{i} = 0$) therefore, the student's debt is

$$\mathtt{DEBT}_0 = \mathtt{NEW\_TUITION}.$$

During the second year, the debt from the first year accrues interest and the tuition for this year is $(1 + \mathtt{INF}) * \mathtt{NEW\_TUITION}$. Therefore, the student's debt after the second year ($\mathtt{i} = 1$) becomes

$$\begin{aligned}
\mathtt{DEBT}_1 &= (1 + \mathtt{BOND}) * \mathtt{DEBT}_0 + (1 + \mathtt{INF}) * \mathtt{NEW_TUITION} \\
&= (1 + \mathtt{BOND}) * \mathtt{NEW_TUITION} + (1 + \mathtt{INF}) * \mathtt{NEW_TUITION} \\
&= (2 + \mathtt{BOND} + \mathtt{INF}) * \mathtt{NEW_TUITION}.
\end{aligned}$$

The process continues during the third year, fourth year and so until the student graduates. Specifically, after year $2014 + \mathtt{i}$ for $\mathtt{i} \leq \mathtt{N} - 1$, the student's debt is

$$\mathtt{DEBT_i} = (1 + \mathtt{BOND}) * \mathtt{DEBT_{i-1}} + (1 + \mathtt{INF})^{\mathtt{i}} * \mathtt{NEW\_TUITION} \tag{3}$$

in real dollars.[6] To summarize, the student graduates in the year $2014 + \mathtt{N} - 1$ with debt $\mathtt{DEBT_{N-1}}$.

4.2. **Gap years.** As in the current system, the student does not begin earning the specified starting salary $\mathtt{SALARY}$ until $\mathtt{GAP}$ years after graduating. During this time, the debt is accumulating interest (which in the proposed system is governed by the ten-year treasury bond rate rather than inflation). This means, at the end of the year $2014 + \mathtt{N} + \mathtt{GAP} - 1$, the student's debt has now accumulated to

$$\mathtt{DEBT_{N+GAP-1}} = (1 + \mathtt{BOND})^{\mathtt{GAP}} * \mathtt{DEBT_{N-1}}$$

in terms of the real dollars in the year $2014 + \mathtt{N} + \mathtt{GAP} - 1$.

4.3. **Professional years.** The student (now a professional) begins earning the specified starting salary. Precisely, in the year $2014 + \mathtt{N} + \mathtt{GAP}$, the salary in real dollars is $\mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}}$. In this first year earning a salary, the debt first accumulates interest so that initially the new debt becomes

$$(1 + \mathtt{BOND}) * \mathtt{DEBT_{N+GAP-1}}.$$

[6]Using induction, one can prove the following closed formula

$$\mathtt{DEBT_i} = \left(\sum_{j=0}^{\mathtt{i}} (1 + \mathtt{BOND})^{\mathtt{i-j}} * (1 + \mathtt{INF})^{\mathtt{j}} \right) * \mathtt{NEW\_TUITION}.$$

The student is then responsible for paying back a percentage of the salary toward the loan. This percentage is determined by the HECS-HELP minimum repayment rates which depend on the student's income adjusted for inflation. The thresholds for the minimum repayment rates in the proposed system are the same as in the current system, with an additional threshold with a repayment rate of 2% for salaries above \$50638 and less than the next threshold. See [3] for details. Since this new threshold of \$50638 is for the year 2016, we modify this by the inflation rate to translate it into 2014 dollars.

Let us temporarily denote $\mathtt{X}$ as the salary in today's dollars (i.e., $\mathtt{X} = \mathtt{SALARY}$). Then the repayment rate is:

$$\mathtt{REPAY\_RATE} = \begin{cases} 0\% & \text{if } \mathtt{X} < 50638 * (1+\mathtt{INF})^{-2} \\ 2\% & \text{if } 50638 * (1+\mathtt{INF})^{-2} \le \mathtt{X} < 51309 \\ 4\% & \text{if } 51309 \le \mathtt{X} < 57153 \\ 4.5\% & \text{if } 57143 \le \mathtt{X} < 62997 \\ 5\% & \text{if } 62997 \le \mathtt{X} < 66308 \\ 5.5\% & \text{if } 66308 \le \mathtt{X} < 71277 \\ 6\% & \text{if } 71277 \le \mathtt{X} < 77194 \\ 6.5\% & \text{if } 77194 \le \mathtt{X} < 81256 \\ 7\% & \text{if } 81256 \le \mathtt{X} < 89421 \\ 7.5\% & \text{if } 89421 \le \mathtt{X} < 95287 \\ 8\% & \text{if } 95287 \le \mathtt{X}. \end{cases} \tag{4}$$

We will use the variable $\mathtt{PAID_i}$ to represent the amount the student has already paid toward the loan at the end of the year $2014 + \mathtt{i}$ in today's dollars (i.e., taking inflation into account to represent the amount in 2014 dollars). Note that for $\mathtt{i} = \mathtt{N} + \mathtt{GAP} - 1$, $\mathtt{PAID_i} = 0$ as the student has not paid anything toward the debt.

At the end of the year $2014 + \mathtt{N} + \mathtt{GAP}$, the amount that the student has paid for his or her education so far is

$$\mathtt{PAID_{N+GAP}} = \mathtt{SALARY} * \mathtt{REPAY\_RATE}$$

in today's dollars. In real dollars for this year, the student pays $\mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}} * \mathtt{REPAY\_RATE}$ toward the debt. Therefore, at the end of this year, the new debt becomes

$$\mathtt{DEBT_{N+GAP}} = \mathtt{DEBT_{N+GAP-1}} * (1 + \mathtt{BOND}) - \mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}} * \mathtt{REPAY\_RATE}.$$

As in the current system, the salary increases in each subsequent year by $\mathtt{RAISE}$ percent in real dollars. In the year $2014 + \mathtt{N} + \mathtt{GAP} + \mathtt{i}$, the salary in real dollars is

$$\mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N+GAP}} * (1 + \mathtt{RAISE})^{\mathtt{i}}. \tag{5}$$

Let us again denote by $\mathtt{X}$ the new salary in today's dollars. By taking into account inflation, $\mathtt{X}$ is simply the above number divided by $(1 + \mathtt{INF})^{\mathtt{N+GAP+i}}$.

Namely,

$$\mathtt{X} = \mathtt{SALARY} * (1 + \mathtt{INF})^{-\mathtt{i}} * (1 + \mathtt{RAISE})^{\mathtt{i}}.$$

In the year $2014 + \mathtt{N} + \mathtt{GAP} + \mathtt{i}$, the debt first accumulates interest and then the student pays REPAY_RATE percent of his salary in real dollars (as computed in (5)) toward the loan. Here the repayment rate REPAY_RATE is provided by formula (4) which depends on X. Since the student pays REPAY_RATE of his/her salary toward the debt in this year, at the end of this year, the student has now paid

$$\mathtt{PAID}_{\mathtt{N}+\mathtt{GAP}+\mathtt{i}} = \mathtt{PAID}_{\mathtt{N}+\mathtt{GAP}+\mathtt{i}-1} + \mathtt{X} * \mathtt{REPAY\_RATE}$$

in today's dollars for the education. At the end of this year, the debt is now

$$\begin{aligned}\mathtt{DEBT}_{\mathtt{N}+\mathtt{GAP}+\mathtt{i}} =& (1 + \mathtt{BOND}) * \mathtt{DEBT}_{\mathtt{N}+\mathtt{GAP}+\mathtt{i}-1} - \\ & \mathtt{SALARY} * (1 + \mathtt{INF})^{\mathtt{N}+\mathtt{GAP}} * (1 + \mathtt{RAISE})^{\mathtt{i}} * \mathtt{REPAY\_RATE}.\end{aligned}$$

This continues until the total debt has been repaid.[7]

References

[1] *https://github.com/sn6uv/debt_website*.

[2] *http://studyassist.gov.au/sites/studyassist/payingbackmyloan/loan-repayment/pages/loan-repayment*.

[3] *http://www.education.gov.au/public-universities*.

[4] *http://students.anu.edu.au/fees/domestic/csp.php*.

[5] *http://students.anu.edu.au/fees/pdfs/ISF-schedule-2014.pdf*.

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[7]As in the current system, the student may not repay the entirety of the debt before retirement. In this case, this process terminates (as in the current system) 50 years after graduation.