YIELD-PROPORTIONAL TERTIARY EDUCATION FUNDING

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Introduction

This university funding proposal will lower unemployment and increase GDP for a given level of employment. It does this without affecting inflation or the government's balance sheet.

The Importance of Prices

Friedrich Hayek, Nobel Prize-winning economist, said that "prices formed on the market tell the individual what to do and what not to do in the social interest."[i] The way we currently decide on a degree's funding is by picking numbers that sound good. The current prices for the university system are $5000, $10,000, and $15,000. [ii] Why those exact prices? Why not $4897.23? Why are there three price tiers? Why not two, or four? Why not seventeen? The policymakers in higher education pulled their numbers out of thin air. Prices are incentives.[iii] People respond to incentives.[iv] If we don't like the way the universities are behaving, it's because the incentive system makes bad behaviour profitable. Is it any surprise that a system with no logical foundation produces unwanted results? Universities are signing up students that are incapable of completion, and graduates are being over- or undersupplied in almost every area. This is not the fault of the universities; it is a failure of the current pricing system. Tweaks to the current system will not fix these issues. What about the proposal to deregulate fees? It failed because it equilibrated student demand with degree supply and it forced a rather large externality of income-contingent loan risk onto the taxpayer. Ideally, we'd equilibrate business demand with labour supply and have no externalities. To achieve this, I've created a mechanism to fund degrees in proportion to the increase to tax revenue that they generate. This links degree funding to student outcomes. I've proven that a variant of my model is Pareto efficient. It is clear from the proof that my proposal is the only possible Pareto-efficient funding system (surprisingly, a system without government financing is not Pareto efficient).

Defining the Yield

Government-financed degrees are investments. Graduates typically earn more than they would have had they not studied. Consequently, they pay more tax. But that's not the only benefit to the taxpayer: the government also pays less in welfare payments, incarceration costs, and healthcare. We will call this total yield to the taxpayer *the increase in net tax revenue*. Each of these factors are measurements that the government can already access; the government only needs to consolidate this information into a single database. Once the yield of a degree is known, we can rationally determine its funding. A degree's funding should be proportional to the increase in net tax revenue that it creates.

Determining the Yield

The problem with funding in proportion to yield is that we don't know the yield until after decades of measuring net tax revenue. Fortunately, the solution is simple—we wait. Let's say the government is paying for a company's service but its true value can't be known until after two years. If we delayed payment by two years, we could give the company a fair price (including a single interest payment at the time of maturity). If the company requires liquidity, they could sell their future revenue claim in the financial market. After we have the data from the two years, we pay whomever owns the claim the valuation of the company's service. This method of payment works with longer valuation periods—say, thirty years. This is how we should pay universities.

Counterfactual Tax Paid

We cannot rationally fund degrees without knowing their yield. To know a degree's yield, we have to know the future earnings of its students and estimate what the student would've earned had they not studied, a counterfactual. Not measuring future earnings is like having a long jump competition without a tape measure. Not estimating the counterfactual is like not paying attention to where each person jumps from. Under yield-proportional funding, every former student of the same degree (with the same major, from the same university, and with the same commencement date) will pay the same fee per class. Therefore, to correctly value a degree, we must know what the average entrant in that degree would have earned had he not entered university. A degree's financial value is the difference between the average net tax revenue of its entrants and that of the average entrant's counterfactual.

The Fundamental Effects on University Behaviour

Reducing Attrition

A dropout who earns a non-entrant salary has a negative yield because of his time spent out of work. The university would make a loss on this student. Therefore, it's in the universities' interests to prevent attrition. Right now, universities have no direct incentive to check a student's suitability towards his "desired" degree, which results in many students switching programs after realizing that their true interests lie elsewhere. Nor is there any direct incentive to prevent the admission of incapable students. Andrew Norton wrote that "While [Grattan] rejected proposals for a minimum ATAR, we also found considerable evidence that there is a problem."[v] Yield-proportional funding makes every student admission into a bet: a university has to determine whether a student will benefit financially by studying his chosen degree. If not, the university will lose revenue. Yield-proportional funding will curb the number of offers to low-ATAR students without preventing the admission of low-ATAR students who show that they are capable of completion. It will shift the risk that is currently on taxpayers onto the universities. Another benefit of the attrition incentive is that it will strengthen existing incentives to improve teacher quality and to increase student support, both social and academic.

Degree Distributions and Content That Better Reflect Predicted Market Demand

To maximize revenue, universities would need a more appropriate degree distribution: the number of students in a particular degree should be representative of that degree's career prospects. This will result in better financial outcomes for students and, consequently, a greater return for universities. Birmingham has stated the need for such an incentive on several occasions: "In all fields of study, it must be the responsibility of universities to be mindful of the numbers of students they enrol relative to the employment opportunities for such graduates."[vi] "We have to have a look at how financial incentives the government has in place actually drive behaviour by the universities in their decision in how many people to enrol in different disciplines."[vii] Some may perceive this advantage of the policy to be unfair to students of particular degrees. Their empathy is short-sighted. Supporting students in low-yield degrees will be good to those students during their study. Then they're going to graduate—and most of them won't ever find a well-paid job. To argue against this is to say that the degree actually has a high yield, thus any argument for the financial benefits of low-yield degrees is self-contradictory. Short-sighted empathy has condemned these students to a lifetime of low pay and low living standards. The *right* thing to do is to incentivize universities to only accept students who will benefit from the degree. We should be opposed to masses of mediocrity being accepted into what *should be* elite degrees. There is no market for mediocre actors. Only the best prospective students should be accepted into these sorts of traditionally low-yield programs.

Some may think yield-proportional funding is an attack on society's intellectual or artistic diversity. However, universities aren't the sole cultivator of this diversity—nor are they the best in all areas at doing so. It may be more accurate to say that yield-proportional funding diminishes the intellectual diversity of *universities*—but even this would be an overstatement. Regardless of if the universities want to fill their classrooms with high-yield degrees, *that* level of student demand for those subjects simply won't be there. And it's better to have a room full of low-paying students than an empty room. If a university's net present value for teaching a degree is above zero and the degree isn't taking resources from degrees with higher net present values, then it is always in the interests of universities to teach that degree—no matter how close to zero that value is. Yield-proportional funding only eliminates degrees whose cost to teach outweighs its financial benefit to students—and that's only assuming that those degrees won't change in the face of extinction either by reducing costs or increasing the earning capacity of its students. Successful changes will be copied amongst universities and unsuccessful ideas will be left behind. Degrees that lack business demand will create more stringent admissions standards so that the difficulty, and prestige, of these programs can be raised. Another benefit of yield-proportional funding is that the tertiary education system would have a unified funding model that won't irrationally favour one type of training.

Implementing Yield-Proportional Funding

The Funding of a Degree

Graduates who become stay-at-home parents contribute smaller net tax revenue increases, thus universities would favour enrolling male students over female ones. I've created formulas that avoid this issue, but for the sake of explanation, the following formulas show a market in which both sexes earn identical salaries.

$$F = k \cdot \Delta T$$

Where

F is, in short, a degree's total funding.[1] (More accurately, it is the total face value the government pays to the degree's bondholders at maturity.) Degrees are distinguished by university, major, and date of student commencement.

k is the proportion of the increase to net tax revenue that the university receives. All degrees initiated in a particular semester have the same k value.[2] The government could choose k such that university funding remains at current levels. Thus, the taxpayer would receive the benefits of yield-proportional funding at no increase in government expenditure. However, k would likely need to be set slightly above this level to get wide-scale university support.

ΔT is the total increase in net tax revenue from all former students who studied the degree. If student fees are added to the system, doubtful debt and student repayments are *not* included in ΔT.[3]

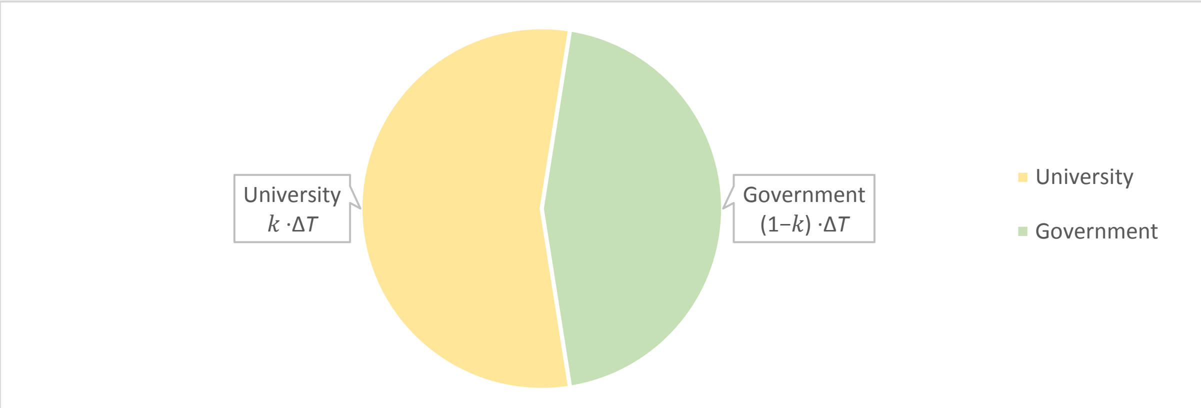

Figure 1. The distribution of the increase in net tax revenue between universities and government depends on the value of *k*.[4]

[1] Note that the cost of providing a degree plays no factor in its funding. If a pizza cost $1000 to make, the pizza maker doesn't get a government subsidy and some profit on top—he must reduce his costs. The idea that the value of something is the cost to make it has been thoroughly debunked. See *Problems with the Cost Theory of Value*. Economics now uses the Marginal/ Subjective theory of value.

[2] If they didn't, courses with lower k values are arbitrarily disadvantaged.

[3] It's more accurate to describe doubtful debt and direct student subsidies as *missed inflows* rather than outflows. Adding or removing student fees from the system should not affect a university's preferences. But including doubtful debt in ΔT *would* change the relative magnitudes—and potentially even the order—of the different financial values of degrees to the university. Student fees are rent-seeking: the transfer of money from students to the government adds no value to the overall economy (other than the prevention of distortionary effects of people favouring government-funded education over other forms of training). The true purpose of yield-proportional funding is to incentivise universities to *create value* rather than simply take money from students.

[4] Note that for illustrative purposes throughout the document, an arbitrary value for k was chosen.

Decentralized Prediction with Yield-Proportional University Bonds

While the government has the benefit of waiting for the true pricing of the degree, the universities are having to make decisions in the present. To do so effectively, universities would need to forecast wages for their degrees. In order to finance their current operations and mitigate risk, universities would sell some of their future revenue claims in financial markets. Including these markets in the valuation further decentralizes prediction. To inform market participants and improve price stability, anonymized data on the tax paid by every entrant and their counterfactual would be publicly available.[5] To make the total value of a degree easier to trade, F is split into $1000 \cdot k \cdot n_S$ bonds.

$$B = \frac{F}{1000 \cdot k \cdot n_S}$$

$$= \frac{\overline{\Delta T}}{1000}$$

Where

n_S is the degree's total number of students who enrol in the same semester.

B is the face value of a degree's single "bond" (they are, in fact, hybrid securities).

$\overline{\Delta T}$ is the degree's average former student's increase in net tax revenue.

Bonds are distinguished by university, degree, major, and date of student commencement. For example, there's a one type of bond for UQ's B.Sc. maths majors who started in first semester 2016, and another type of bond for UQ's B.Sc. maths majors who started in second semester. Since the bonds last thirty years, there can be up to 59 bond types for UQ's B.Sc. maths majors at any point in time. And there can be 59 more bond types for UNSW's equivalent program at any point in time. Yield-proportional funding would establish a *massive* new financial market. If universities sold all their bonds, every single cent of student funding would flow through the financial markets.

The market's purpose is to accurately value a degree's bonds. For a bond buyer to maximize his profit, he buys the bonds until the resulting increase in the bond price makes purchasing more bonds unprofitable according to his valuation. This results in the bond buyers paying universities the market estimate of F: universities are paid in proportion to the *estimated* financial yield that their degrees provide to the taxpayer. Universities can receive higher funding by improving their services' total market valuation. The primary means by which they can do this are by preventing student attrition and providing student numbers that are representative of each degree's career prospects.

An additional result of the market's bond valuations is that students will have high-quality estimations of the value of each degree: since the average increase to net tax revenue is the only variable of a bond's value, it's trivial to convert the price of each bond into the student's expected increase in earnings.[6] The expected increase to earnings would be required to be prominently displayed on a degree's information page so that students can easily compare the financial values of degrees.

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[5] Identity information that has no correlation with yield, such as first and last names, would be stripped from the data. The ages of the former students could be randomly modified from -2 to +2 years to further anonymize the data without compromising its predictive capacity.

[6] B, the value of the degree's bond, is proportional to the average change in taxation. Since taxation beyond the minimum tax bracket has a one-to-one correspondence to earnings, an inverse function exists for most values. Therefore, given the size of a degree's average tax payment, we can determine the average income. We can do the same for the counterfactual. By subtracting the average wage of the counterfactual from the average wage of the former students, we have estimated the prospective student's expected increase in earnings.

The Coupon Payment of the Bonds

The longer the measurement period, the better; the only non-arbitrary time to stop the measurement period is when all the former students are dead. So why stop at thirty years? For the initial price of university bonds to represent only a degree's expected increase in net tax revenue, we must have a coupon rate equal to the return on investment (ROI) of a traditional government bond issued in the same period. Thirty years is Australia's longest traditional government bond. Thus, yield-proportional university bonds last thirty years. The value of the coupon at maturity is as follows:

$$C = B \cdot \left((1 + R_{29}) \cdot (1 + R_{28}) \cdot \ldots \cdot (1 + R_0) - 1\right)$$

Where

> C is the coupon paid (per bond) at maturity. Since its value depends on the value of B, which cannot be known until maturity, the coupon must be paid in bulk at maturity.
>
> R_i is the annual ROI of a traditional government bond that has the same number of years to maturity, i. A university bond's coupon rate is equal to the ROI of traditional thirty-year government bonds issued in the same period.

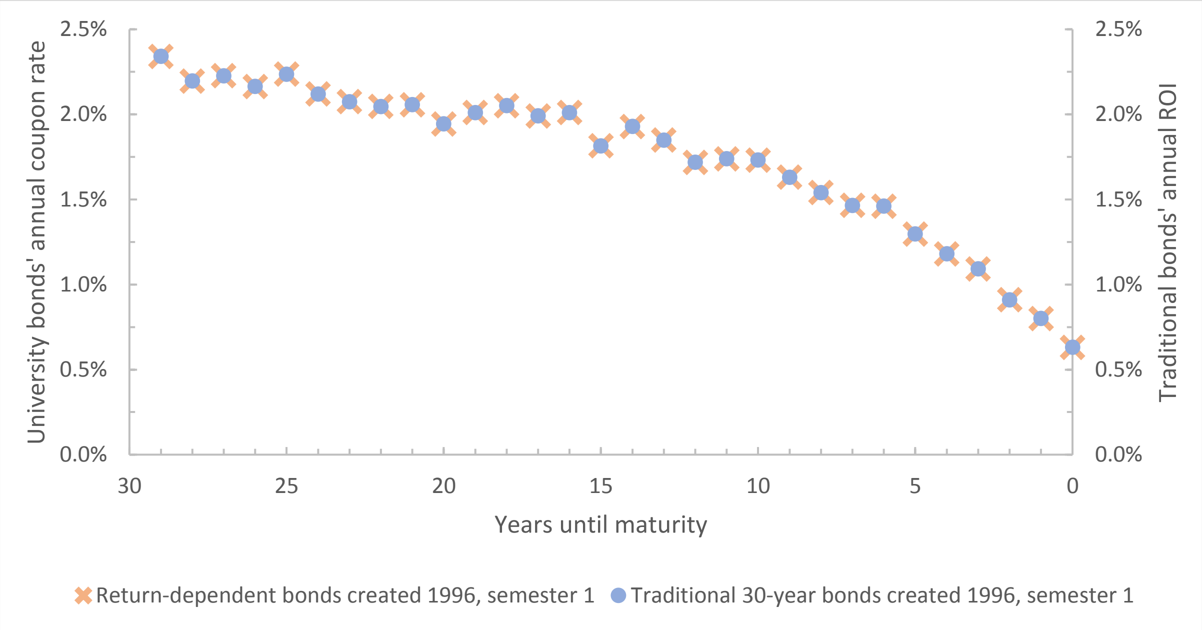

Figure 2. The annual coupon rate of a yield-proportional bond is the same as the annual ROI of a traditional bond that has the same number of years to maturity.

For a hypothetical degree with zero risk, we would—by the definition of zero risk—*know* the face value of the university bond thirty years in advance, thus the bond buyers would pay the university the face value while receiving the same ROI that they would have earned if they had instead bought a traditional thirty-year government bond. Of course, no degree has zero risk, so to create a risk premium, bond buyers will pay universities below the estimated face value for a bond in proportion to the risk of the career prospects of that degree. We know that this underpayment is proportional to the risk because we can assume that it's equally profitable to invest in any degree over the long term. If this weren't the case, some bonds would have higher long-term yields, which would increase demand for those bonds, thus their price would increase, therefore the long-term yield of all bonds must equalize. Since the cost to the government of a zero-risk degree's bond is the same as a traditional thirty-year bond, and since all university bonds have the same cost to government over the long term, all university bonds have the same cost to government as traditional bonds over the long term.

The Viability of the Counterfactuals

High Variance of the Counterfactuals

Because there is a distinct counterfactual for each combination of degree, major, university, and commencement date, the "sample sizes" of each bond are small, thus a bond's *mature face value* may have a lot of variance that is not due to the actual value of its respective degree. For instance, the mature face value of a bond for UQ's B.Sc. maths majors in 2020's first semester may drastically differ from the mature face value of UQ's same degree and major from the following semester. Though this initially seems to be a big issue, it's actually no issue at all.

Definition of Precision and Non-Bias

To prove this, we must understand the difference between precision and non-bias. If we measure the weight of a bag of oranges on a scale several times, and, each time, the scale produces the same result, the scale can be said to be *precise*. On a second scale, if each time we measure the same bag of oranges with wildly different results but the average of those results is the true weight of the bag, then that scale can be said to be *non-biased*.

Proof that Precise Initial Pricing Only Requires Non-Biased Counterfactuals

If an investor has a portfolio of 100 bond types that would all be worth $300 if the counterfactual was 100% precise, then he should get an *average payout* of $300 per bond when the counterfactuals are imprecise but non-biased. If the investor has no way of knowing which bonds will eventually be over- or undervalued, his initial valuations should be $300 for every bond type. Therefore, we have accurate initial valuations of degrees *despite the eventual payouts for a particular bond potentially being wildly imprecise*. Of course as the earnings data flows in, the face values will diverge randomly—but, for yield-proportional funding to work, the only price that matters is the bond price at commencement because that's what affects university behaviour. The mature face values are irrelevant as long as they facilitate accurate initial pricing. For this facilitation to occur, the mature face values must be non-biased in the long run and any imprecision must be non-exploitable by investors during initial pricing.

The Pareto Efficiency of Yield-Proportional Funding

Definition of Pareto Improvement and Pareto Efficiency

A Pareto improvement increases one person's welfare without subtracting from anyone else's welfare. Pareto efficiency is a state in which no further Pareto improvements are there to be made.

Requirements for a Pareto Improvement in Any University Funding System

There are three requirements for a Pareto improvement in any university funding system:

1. A student will not study a degree unless the student predicts it will increase their utility: $EV\big(Utility_i(degree_i, \Delta I_i - repayments_i)\big) - EV\big(Utility_i(no\ degree)\big) \geq 0$.
2. The university will not admit a student unless the university expects a benefit: $EV(funding_i) - EV(cost\ of\ teaching_i) \geq 0$.
3. No taxpayer can expect to be worse off because of any student admitted into university: $EV(\Delta T_i) - EV(funding_i) + EV(repayments_i) \geq 0$.

Where

$EV(x)$ is the expected value of x.

ΔT_i is the increase in net tax revenue due to the i^{th} student.

ΔI_i is equal to the i^{th} student's change in income after tax and before repayments.

Proof That Every Student Is a Pareto Improvement in Yield-Proportional Funding

Note that the inequalities for the student and the university are always satisfied: students maximize their own expected utility and universities won't admit a student if doing so is against the university's self-interest. For yield proportional funding, $EV(funding_i) \equiv EV(k \cdot \Delta T_i) = k \cdot EV(\Delta T_i)$. Therefore, by substitution into the taxpayer's inequality, $EV(\Delta T_i) - k \cdot EV(\Delta T_i) + EV(repayments_i) \geq 0$. Thus, $(1-k) \cdot EV(\Delta T_i) + EV(repayments_i) \geq 0$. Since $0 \leq k \leq 1$ and $EV(repayments_i) \geq 0$, this inequality will hold if $EV(\Delta T_i) \geq 0$. We can show that this is the case. For the universities, after substitution, $k \cdot EV(\Delta T_i) - EV(cost\ of\ teaching_i) \geq 0$. Thus, universities won't take on a student if $k \cdot EV(\Delta T_i) < EV(cost\ of\ teaching_i)$, therefore $EV(\Delta T_i) \geq 0$, thus the inequality for the taxpayer is satisfied. All inequalities hold, therefore each accepted student must be a Pareto improvement.

Proof That One Variant of Yield-Proportional Funding Is Pareto Efficient

Let us assume that the system is not Pareto efficient. Therefore, a Pareto improvement exists that is not exploited. For the taxpayer to have an improvement, the university must have an improvement. But for this improvement to occur, one of two things must happen. The first scenario is that the value of k could be too low. Here, $EV(\Delta T_i) \geq EV(cost\ of\ teaching_i)$ is met and $k \cdot EV(\Delta T_i) \geq EV(cost\ of\ teaching_i)$ is unnecessarily not met. Let $k = 1$ to avoid this issue. The second scenario is that the student must choose a different degree than their original choice. The full range of Pareto improvements might not be realised if $EV(repayments_i) > EV(\Delta I_i)$ for some student. Let the student fees be zero to avoid this issue: since the student's choices are limited to Pareto improvements, else the university would not admit the student, $EV(\Delta I_i) > 0$. Since the student is already self-maximizing (within the bounds of what the university will let them do), they will not make a different choice of degree. Therefore, if we assume $k = 1$ and $repayments = 0$, a contradiction occurs: no further Pareto improvement exists. Therefore, this variant of the system must be Pareto efficient.[7]

[7] Note that I am *not* recommending the provably Pareto-efficient variant of the policy, which would reduce the benefit of the taxpayer to zero (ignoring any Keynesian multiplier effects). Variants with student fees above zero and lower values of k can be Pareto efficient, but not provably so without data.

Conclusion

Overview of Cash Flows and Bond Sales

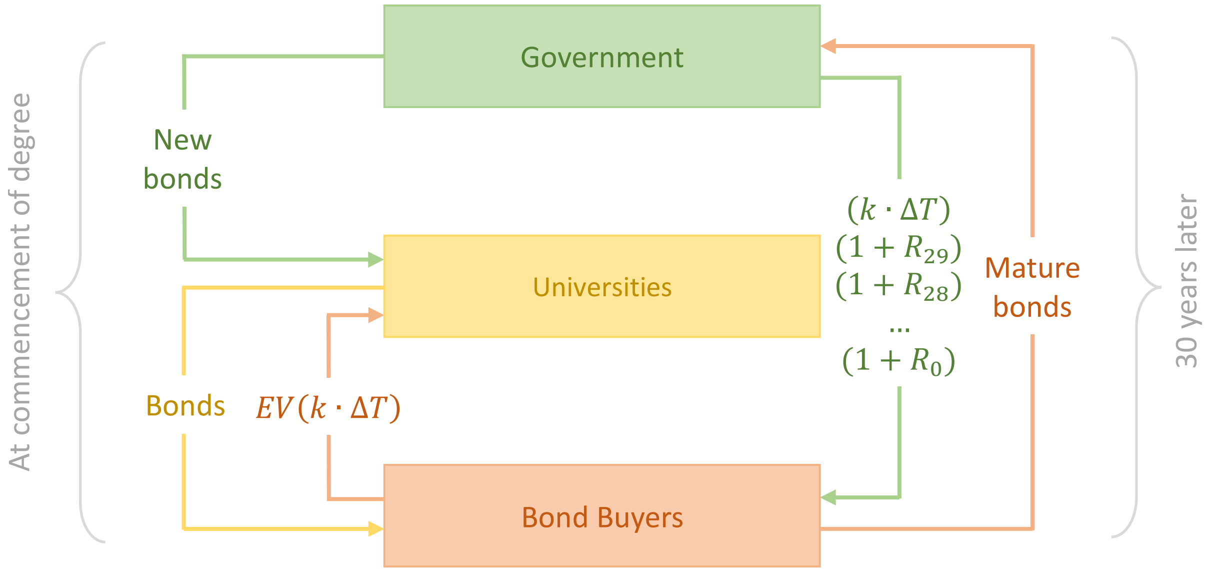

Figure 3. Overview of yield-proportional funding's cash flows and bond sales excluding cash flows from former student.

After the commencement of each semester, the government gives the university $1000 \cdot k$ bonds per new student. Four factors distinguish bonds: university, degree, major, and date of student commencement. Immediately upon receiving the bonds, the universities sell their bonds in the financial markets. The face value of these bonds is proportional to the average increase in net tax revenue—hence their face value cannot be known until thirty years after they are issued (and the coupon must be paid as a lump sum at maturity). For the markets to maximize profits, investors must accurately evaluate the financial value of a degree by determining the long-term career prospects of its graduates. If they overestimate, they pay too much; underestimate, and they underinvest. When market participants purchase the bonds, they reveal their estimate of a bond's future value, $\overline{\Delta T}/1000$. Since $\overline{\Delta T}$ is the only variable, the market has revealed its estimate of the degree's average boost to net tax revenue. For a university to maximize their funding, they must respond to the bond market's valuation of their degrees by providing student numbers that are representative of a degree's career prospects. Thus the universities attain some of the discipline of the market and a degree's value is predicted in a decentralized manner. In some cases, the university may choose to retain a degree's bonds if they believe the market has undervalued that degree. After thirty years, the measurement of net tax revenue is complete and (variance disgarded) the government pays the bondholders the true value of the bonds, $\overline{\Delta T}/1000$ per bond.

Figure 4. The cash flows from former students to government assuming no fees.

At any point after commencing their degree, the government receives returns via an increase in net tax revenue. Since the universities are paid proportionally to the government's yield, yield-proportional university funding is—by definition—self-sustainable without any student fees whatsoever. I would, however, recommend having student fees. I've removed the page and a half that outlined exactly what the fees should be because they distracted from the main point of the essay.

Epistemological Failures of the Current System

We need methods to evaluate whether a policy is good. This is an epistemological problem. In the sciences, if a theory is falsified by experiment and then the theory is amended to account for the new experimental data, the amendment is called an *ad hoc hypothesis*. Such theories are generally rejected because scientists know from experience that the amended theory is likely to be falsified again. The strength of established scientific theories is that they accurately predict otherwise unexpected data. Similarly, funding systems should be able to automatically stabilize in response to unexpected shocks. We should not need ad hoc interventions, such as the proposal to increase student loan fees by 15% or the manual repricing of degrees. Mathematicians, physicists, and moral philosophers start from first principles to reach conclusions, and the strength of those conclusions justifies or disproves the first principles. This is an example of what is called *coherentism*. Unfortunately, it seems that policymakers in education funding don't use first principles. How were the exact prices of $5000, $10,000, and $15,000 reached? Why are there exactly three pricing tiers? Why are the same degrees from different universities always in the same price tier? There is no logical foundation to these decisions. These policymakers' analysis doesn't go beyond the "Will it work for the next five years?" criterion. And then they blame the universities for the over- and undersupplies of various degrees, and high rates of attrition. The real issue is that such behaviours by the universities are profitable. Why? Because the system was poorly designed. A system with no logical basis will always produce unwanted results. Tweaking the current system will not fix the fundamental issues.

Yield-Proportional Funding

From a purely financial perspective, the benefit of a degree to the taxpayer is the increase in net tax revenue. It's quite simple to quantify this after the fact, but, for any practical purpose, we seem to require that the government to predict the future. The intellectual leap was to realize that the government could wait and the market could serve as the predictor. The current system depends on the collective economic prediction of, largely, 17-year-olds. This can obviously be improved. However, providing students with better information on graduate outcomes is insufficient to improve the degree distribution. One only needs to look at the six billion dollars of doubtful debt to see that student response to predicted market demand is limited. If they did respond significantly, the degree distribution would not be what it is; most Fine Arts students *know* that average graduate outcomes are generally poor for their degree, but each student believes he'll beat the odds. So even if prospective students were given *100 percent accurate* information about the future of the average graduate for each degree, many of them would still make poor choices—and the universities would be all too happy to oblige under the current funding system. In contrast, if universities had access to, say, 70 percent accurate information (from the financial market's bond value estimations) and their funding was dependent on acting on that information, the universities would act on it.

Market Accuracy Is Not the Point of Yield-Proportional Funding

The obvious question arises as to whether the market will indeed be accurate in its predictions. *Efficient markets*, by definition, fully and promptly incorporate all available information rationally to update the expected net present value. The market will never be anywhere close to 100 percent accurate—but it is the best tool we have to predict future economic needs.[viii] However, to think that yield-proportional funding's purpose is to improve prediction misses the point entirely. We *know* that some degrees are bad at increasing wages and others are good—and we generally know which is which. Yield-proportional funding is about making universities act on what we already know. It's an incentive system that aligns the universities' financial self-interests with the interests of society. Universities will act to decrease attrition by improving admissions and student support, and act to increase the employability of their graduates by providing a distribution of degrees, and content, that better reflects predicted market demand. Yield-proportional funding will increase economic efficiency, decrease un- and underemployment, improve the lives of countless graduates, and serve as a model for the rest of the world.

(The funding mechanism could also be used for private prisons: yield-proportional funding would accurately assess the full cost of recidivism and provide an adequate financial incentive for prisons to re-educate inmates for entry into the workforce and lower the rate of reoffence.)

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[i] Quoted from Hayek, F. A. (1977, November 7).
[ii] Quoted from Ross, J. (2016, October 10).
[iii] See Boudreaux, D. J. (2008).
[iv] See Mankiw, N. G. (2014).
[v] Quoted from Norton, A. (2015, January 21).
[vi] Quoted from Mathews, K. E. (2016, August 9).
[vii] Quoted from Hare, J. (2016, August 13).
[viii] See Boudreaux, D. J. (2008).

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