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Review of PIF Model

Summary

The PIF Interactive Calculator is a spreadsheet model designed to facilitate the evaluation of "pay it forward" pilot project designs in response to HB 3472, which was passed by the Oregon Legislature in 2013. The "pay it forward" concept is an alternative to student loans, in which students are granted tuition forgiveness in exchange for promising to pay some percent of their future earnings (or income) for some number of years.

The Oregon Higher Education Coordinating Commission (HECC) asked ECONorthwest to look over the PIF Interactive Calculator to ensure its mathematical accuracy and assess the reasonableness of its embedded assumptions and its sensitivity to changes in those assumptions. ECONorthwest is an independent economics consulting firm and does not advocate for or against the PIF concept. The findings and opinions presented in this memorandum are our own and not those of the HECC or anyone else.

We found the model to be mathematically accurate. There are a few places in the model where the results of adding dollar amounts from different years without discounting to a common dollar year are displayed. These appear to have had specific purposes during the development of the model, but none are integral to the function of the model and they could easily be removed or hidden.

We also found the structure of the model to be reasonable and useful. The model starts with estimates of future incomes for college attendees, scales them down with a series of multiplicative factors, multiplies them by the number of participants, and then subtracts estimated administrative costs. It combines these forecasted cash inflows with the value of forecasted tuition waivers (the equivalent of cash outflows) and discounts the results to present value from the institution's perspective. This structure makes the operations of the model simple and transparent. There are few assumptions hidden in the structure of the model and almost all of the policy variables, factual data, and forecasts of future conditions are explicit and easily adjusted by the user. Changes to input values and assumptions have their expected effects on results.

We offer suggestions for making the structure of the model a little more complex in exchange for the ability to explicitly model circumstances that may prove to be important. We also suggest that the model be modified to show the present value of all cash flows associated with 50 years of program operation, including continued repayment beyond the end of new cohorts being accepted. The model currently only shows results through the fiftieth year, which will exceed the present value of cash flows.

Model Structure and Function

The spreadsheet model consists of six tabs. The first two describe expected average incomes and administrative costs. The next two describe the four-year program from the perspectives of the program and the average student. The last two describe the two-year program and are structured the same as the four-year tabs.

User Inputs and Assumptions

The model combines user-supplied inputs and assumptions, using its own logic and built-in parameters, to predict future cash flows. Some of the assumptions are meant to be changed by the user to gain an understanding of how the cash flows might change under different circumstances. These are colored blue in the model and we refer to them as inputs. Some of the inputs are policy variables that serve to define a pilot program, including the number of participants, the contribution rate, and the number of contributing years. These may be changed to test the effects of different pilot program designs. Others are assumptions about future conditions, such as completion rates, rates of change in tuition and administrative costs, the share of non-contributors, etc. These may be changed to test the effects of different future conditions that may not be under direct policy control, but are not currently knowable with certainty.

Income Inputs and Calculations

The income assumptions used by the model are developed in the **Income Series** tab. This tab uses 2011 average earnings data by age and educational attainment from the Census Bureau's *2012 Annual Social and Economic Supplement,* combined with Oregon-specific input values for future graduation rates to define life-cycle average-earnings patterns for people who attend two-year and four-year public colleges in Oregon.

The model cites the OUS *2013 Fact Book* and the CCWD *2011-12 Community College Profile* as sources for the graduation rates, but we could not match the input values in the version of the model we received with those or any other source. The values used here should represent the highest attainment for Oregon students who enrolled in four-year or community colleges and each student should count exactly once. The categories should be mutually exclusive and they do add up to 100%, but the share in the "no degree" category is calculated by subtracting the sum of the others from 100%.

The Census data is reported by five-year age groups and the model assumes that the reported average represents the average income of the middle year of the five years represented. It then uses straight-line interpolation to estimate average incomes for the other ages. This method used should be sufficiently accurate for the purposes of this model.

The data developed for and used in the **Income Series** tab could be used to improve the model by reporting out three series for attendees at each of two-year

and four-year colleges. The three series would represent those who did not complete a degree (including those who attended a four-year college and eventually obtained a two-year degree), those who completed only the degree associated with the program, and those who eventually obtained higher degrees.

Bringing these income series forward separately would allow their associated participants to be modeled separately, which we believe would improve the accuracy of the model and promote the discussion of important issues related to the terms of the PIF agreement. For example, those who do not complete degrees might have lower tuition costs as well as lower earnings, while those who go on to complete advanced degrees might have begin receiving their higher full-time earnings until several years later.

To support improved characterization of adverse selection, the **Income Series** tab could be expanded to capture the distribution of expected earnings. If the terms of the PIF program make the PIF program less desirable at higher income levels, participation by science, technology, engineering, or math (STEM) majors or others with reason to expect higher future incomes, might be lower, reducing the expected average income for those who do participate.

Adverse selection is important because excluding a small number of the highest-income individuals can lower the average income of the remaining population significantly. For example, using the distribution of incomes for 30-year-old college graduates in Oregon as measured by the 2012 American Community Survey, we find that excluding the top one percent of earners (those over $221,000) reduces average earnings by 4.3%. Excluding the top five percent (those over $137,000) reduces the average by 13.0%. Table 1 shows the effects of different levels of adverse selection on average earnings.

Table 1: Effect of Adverse Selection on Average Earnings

Percent Excluded	Threshold Earnings	Average of Remaining	Percent Loss
0%	#N/A	55,093	0.0%
1%	221,281	52,734	4.3%
2%	182,627	51,237	7.0%
3%	161,683	49,999	9.2%
4%	147,526	48,913	11.2%
5%	136,929	47,933	13.0%
6%	128,512	47,033	14.6%
7%	121,559	46,195	16.2%
8%	115,653	45,409	17.6%
9%	110,531	44,666	18.9%
10%	106,017	43,960	20.2%

Source: ECONorthwest

Adverse selection is made possible by the wide dissemination of robust data on earnings by occupation and by field of study. We believe that some students will be able to predict with confidence that their intended degree(s) will lead to higher incomes, making them less likely to participate and lowering the expected average income for those who will participate.

We recommend that the **Income Series** tab be modified to include a characterization of the distribution of expected incomes for use in deriving explicit estimates of adverse selection in the tabs where the adverse selection factor is applied. Including the standard deviations along with the averages would provide sufficient input data for the necessary calculations.

Administrative Cost Inputs and Calculations

Administrative costs may be specified in either of two ways. The estimates of administrative costs for the modeled PIF program are built up from itemized, employee-by-employee estimates of salary and overhead costs. The **Admin Costs** tab also allows the user to specify first-year and subsequent-year administrative cost totals along with a rate of inflation-adjusted cost increases.

The itemized costs include portions of salary for a developer, an administrative specialist, an accounting technician, and a program analyst. The administrative specialist would work full time for the PIF program and the other three would each provide one-tenth of their time to the program after the first year. This staff could set up and maintain accounting and program-management database applications at the multi-institution level, but it seems that additional staff might be required to provide customer service to participants, match tax returns, track down participants who have moved, initiate collection proceedings, etc. By the 25th year, with no increase in the number of new participants each year, there will be approximately 25,000 people participating in some way (in school, in deferral, deceased, making payments that may or may not be for the correct amounts, or failing to make payments that are due). It may be the case that the model is implicitly assuming that the cost of providing customer service functions will be borne by individual institutions and not be considered a cost of the program, or that they will be contracted out. Whatever the case, it appears to us that there will be costs related to dealing with participants throughout the deferral and repayment periods that are not included in the itemized estimates in the model.

The **Admin Costs** tab contains several instances of "25 Yr TTLs," which add undiscounted dollar amounts across 25 years. These are not used anywhere else in the model and should be removed or hidden as they embody an assumed zero-percent discount rate, which is inconsistent with both institutional and individual student's perspectives.

Four-year Program Inputs

The **4 Yr Program** tab contains the inputs that define the PIF program for four-year colleges, along with other conditions that affect the resulting cash flows. Those inputs are:

- Annual tuition cost for in-state, full-time students (set to $8,499, the system-wide average for 15 hours, including mandatory fees)
- Assumed real rate of increase in tuition costs (set to zero)
- Years covered (set to four)
- Contribution rate, or percent of future-year incomes that would be paid back to the program (set to 4.0%)
- Deferred years, or years between end of college and beginning of payments (set to one)
- Real income change, or the rate at which incomes in general increase in the future (set to zero)
- Adverse selection, or the percent reduction in expected program revenue resulting from students who expect higher incomes being less likely to participate in the program, leading to lower than average future incomes for participants (set to zero)
- Non-contributors, or the percent of participants who do not make payments for whatever reason (set to 3.0%)
- Contributing years (set to 20)
- Year 1 class size, or number of pilot program participants from four-year colleges in the first year (set to 450)
- All classes year 1, or whether or not first-year participation will be limited to freshmen or allowed for those who have already paid some tuition (set to zero, meaning freshmen only)
- Class growth rate, or the rate of increase in the number of participants in successive program years (set to zero)
- Institutions' real discount rate (set to 3.0%)

The policy inputs that define the terms of the pilot program (the contribution rate and contributing years) are set to 4.0% for 20 years. At these rates, and given the rest of the assumptions in the model, the first 50 years of the pilot program would have a present value of negative $138 million if it serves 450 four-year college students per year. The model does not show the present value of including the next 20 years of contributions, which would continue if new participation were ended after 50 years. We added the necessary formulas to the model and calculated a present value of negative $95 million for the same 450 new four-year participants per year. We recommend that this functionality be added to the model, as the result shown in the current version of the model overstates the present value of the program's cost.

Alternative input values for several of the inputs might be reasonable. For example, adverse selection will certainly exist and will likely be non-trivial. In addition, the assumption of no real increase in tuition is difficult to believe in

light of historic tuition increases. As shown in the sensitivity analysis below, even a small rate of increase in real (inflation-adjusted) tuition rates leads to large reductions in the financial feasibility of the program. These effects could be partially offset by future growth in real earnings. Until about 15 years ago, real earnings increased steadily at one to two percent per year, reflecting productivity gains. Unfortunately, real earnings have not been increasing recently and zero percent may be a reasonable assumption about the future.

Changing the assumptions for tuition increases and adverse selection, to 1.0% and -13.0% respectively, changes the present value of 50-year cash flows to negative $257 million and the present value of 70-year cash flows, after truncating program entry at 50 years, to negative $223 million for 450 four-year participants per year. These alternative assumptions imply that tuition would increase at one percentage point over inflation and that students expecting to earn in the top five percent would choose not to participate (see above for the effect of adverse selection on the average income of participants).

For the program to be able to scale if it proves successful, it likely will need to come closer to breaking even. The system will require a significant operational subsidy in the early years to cover costs in the absence of tuition payments, but with sufficient contribution rates and contributing years, it would be able to repay all (or most) of the borrowing.

Four-year Program Results

Results are displayed is several formats in the **4 Yr Program** tab . A table of year-by-year cash flows includes:

- Tuition costs by year
- Expected incomes by year
- Average payback by year
- Annual cash flow (before administrative costs)
- Administrative costs by year
- Annual cash flow (after administrative costs)
- "Endowment Need," which is the present value, discounted at the institutions' real discount rate, of cash flows through that year

The table of cash flows also contains a column labeled, "Attrition," which is not identified as a user input, but contains input assumptions without a documented source or explanation. These appear to be factors that adjust for the number of expected deaths among those who would be making payments. They closely match published actuarial life tables. They are not sufficient to account for both death and disability.

In addition to the table of cash flows, there is a graphical representation of cash flows over time and separate reporting of the highest annual cash outflow and the highest "Endowment Need," as well as the "Endowment Need" after 10, 25, and 50 years.

We recommend adding a result showing the present value of 50 years of program operations plus the present value of the contributions that would continue to be received after those 50 years.

Four-year Individual Results

The **4 Yr Indiv** tab re-displays some of the inputs from the **4 Yr Program** tab, but does not require any inputs of its own. There are some hidden inputs related to a pre-payment scheme that is not described and is not fully implemented (some of the inputs are not connected to any calculation). We concluded that the input and result rows related to the pre-payment scheme are not intended to be a part of the current version of the model and left them hidden for this review.

It should be noted that the individual results displayed in the **4 Yr Indiv** tab apply only to the individual with the average income. All other individuals will come out better or worse.

"Net Present Value" shows the value of the subsidy for the individual at the mean income. The discount rate is hardwired inside the formula to 4.5% and should be made an explicit input, like the institutions' discount rate of 3.0%. The present value is discounted to the year before college starts, which makes sense from the perspective of a student deciding whether or not to participate, but is inconsistent with the as-of date for other present value calculations in the model.

Community College Program Inputs

The **CC Program** tab is structured the same as the **4 Yr Program** tab and contains the inputs that define the PIF program for two-year colleges, along with the resulting cash flows. Those inputs are:

- Annual tuition cost for in-state, full-time students (set to $4,537, the average cost of 15 hours at Oregon community colleges, including mandatory fees)
- Assumed real rate of increase in tuition costs (set to zero)
- Years covered (set to two)
- Contribution rate, or percent of future-year incomes that would be paid back to the program (set to 1.5%)
- Deferred years, or years between end of college and beginning of payments (set to one)
- Real income change, or the rate at which incomes in general increase in the future (set to zero)
- Adverse selection, or the percent reduction in expected program revenue resulting from students who expect higher incomes being less likely to participate in the program, leading to lower than average future incomes for participants (set to zero)
- Non-contributors, or the percent of participants who do not make payments for whatever reason (set to 3.0%)
- Contributing years (set to 20)

- Year 1 class size, or number of pilot program participants from two-year colleges in the first year (set to 550)
- All classes year 1, or whether or not first-year participation will be limited to freshmen or allowed for those who have already paid some tuition (set to zero, meaning freshmen only)
- Class growth rate, or the rate of increase in the number of participants in successive program years (set to 0.0%)

These inputs define the terms of the PIF program, the amount of tuition, and the amount of contributions to be collected given expected incomes and proposed payment terms.

Except for the tuition cost, years covered, contribution rate, and class size, the two-year program uses the same assumptions as the four-year program. The tuition rate is lower because community colleges charge less per credit and the years covered is two rather than four. The lower tuition cost and fewer years of tuition lead to a lower contribution rate—1.5%, compared to 4.0% for the four-year program.

The pilot program is defined to add 1,000 students per year–450 in four-year colleges and 550 in community colleges.

Community College Program Results

The community college version of the program tab contains all of the same results in the same formats as the four-year version. All of our comments and suggestions for that tab apply here as well.

Community College Individual Results

The community college version of the individual tab contains all of the same results in the same formats as the four-year version. All of our comments and suggestions for that tab apply here as well.

Comments on Current Input Values

Because of the implicit subsidies described above, the PIF program as currently specified in the model would be a very attractive alternative to student loan financing for most students, even for some who expect to be able to earn higher-than-average incomes after graduation. A participant who achieves average, or even higher-than-average earnings will be receiving a significant implicit subsidy relative to non-participants. As a result, the pilot program being modeled would be expensive and the costs of extending it beyond the pilot to all students who would like to participate could be prohibitive, given the resources available to the State.

As noted above, with the assumptions in the model as delivered, the net present value of losses associated with the four-year pilot program over its first 50 years exceed $95 million and the losses associated with the community college program add another $24 million to that, for a total of over $119 million for a program that can only serve 1,000 new students each year. These amounts include the present value of contributions made through the seventy-first year, with no new participants after the fiftieth year. With alternative assumptions that we believe to be more reasonable, the losses are even larger.

Sensitivity to Changes in Assumptions

To test the sensitivity of the model to changes in inputs, we changed the inputs one at a time and recorded the effects on the present value of cash flows through year 50. Inputs that are in levels were increased by 10% and inputs that are in percents were increased by one percentage point. Table 2 shows the results of the sensitivity analysis.

Table 2: Sensitivity Analysis

Input Assumption	Changed From	To	Change in Result	
Annual Tuition	8,499	9,349	27.28%	worse
Real Rate of Change	0%	1%	61.77%	worse
Contribution Rate	4%	5%	43.81%	better
Real Income Change	0%	1%	54.07%	better
Adverse Selection	0%	-1%	1.75%	worse
Non-Contributors	3%	4%	1.81%	worse
Contributing Years	20	22	12.92%	better
Year 1 Class Size(s)	450	495	9.75%	worse
Class Growth Rate	0%	1%	29.93%	worse
Admin Costs	increased by	10%	0.25%	worse

Source: ECONorthwest

Suggested Model Enhancements

We offer two categories of suggestions for improving the model. Both categories are offered as optional, potential enhancements to an already-functioning model. In the opinion of the reviewer, these enhancements, if adopted, could improve the use usefulness of the model and provide users of the model with greater confidence in its results. One category consists of easy fixes that don't materially affect the results of the model. Those are:

- Remove instances of adding undiscounted dollar amounts across years. Since these sums are not used in other calculations, they can simply be removed or hidden without harming the model.
- Make the discount rate applied to individual participant's cash flows an explicit input, like the discount rate for institutions is.
- Add formulas necessary to show the present values of cash flows through fifty years of program operation plus the contributions that would continue on if new participation ended at fifty years.

Our suggestions in the other category involve adding additional complexity to the assumptions about educational attainment and future earnings. We believe that the added complexity will be worth the increased confidence one could have in the results, given that we know not every participant will complete their intended degree, that some of those who do complete their intended degree will go on to graduate school, and that actual incomes of participants will vary widely. We also believe that some students will be able to predict with confidence that their intended degree(s) will lead to higher incomes, making them less likely to participate and lowering the expected average income for those who will participate.

Our suggested enhancements to address these issues could be implemented in a way that would allow the inclusion in the model of participation in both the community college and the four-year programs by the same student. For example, a student might start out in the community college program with two years of tuition at the community college rate, and then complete two years at a four-year school at the four-year rate.

We recommend adding (or moving) the following inputs to the **4 Yr Program** tab:

- Share of students enrolled for one year
    - Share of those who will obtain a 2-year degree somewhere
    - Share of those who will obtain a 4-year degree somewhere
- Share of students enrolled for two years
    - Share of those who will obtain a 2-year degree somewhere
    - Share of those who will obtain a 4-year degree somewhere
- Share of students enrolled for three years
    - Share of those who will obtain a 4-year degree somewhere
- Share of students enrolled for four years
    - Share of those who will obtain a 4-year degree
        - Share of those who go on to graduate school
- Share of students enrolled for five years
    - Share of those who will obtain a 4-year degree
        - Share of those who go on to graduate school
- Share of students enrolled for six years
    - Share of those who will obtain a 4-year degree
        - Share of those who go on to graduate school

- Number of freshman enrollees
- Number of sophomore transfers of CC participants
- Number of junior transfers of CC participants

- Additional years of deferral for those who go on to graduate school
- Traditional student loan interest rate
- Traditional student loan repayment period
- Individual discount rate (see above)
- Share of above-break-even income students who will not participate

We recommend adding (or moving) the following inputs to the **CC Program** tab:

- Share of students enrolled for one year
    - Share of those who will obtain a 2-year degree somewhere
    - Share of those who will obtain a 4-year degree somewhere
- Share of students enrolled for two years
    - Share of those who will obtain a 2-year degree
    - Share of those who will obtain a 4-year degree somewhere
- Share of students enrolled for three years
    - Share of those who will obtain a 2-year degree
    - Share of those who will obtain a 4-year degree somewhere

We recommend adding inputs to the **Income Series** tab for standard deviations or relative variation for each of the series of average incomes that are already

there. One relative variation (ratio of standard deviation to mean) input for each series would be sufficient and would allow the calculation of a standard deviation for each average income by age and attainment. The American Community Survey Public Use Microdata Sample (ACS PUMS) could be used to calculate appropriate input values.

We recommend adding the calculation of a break-even income series for each number of years enrolled for each program. This income series would leave the student indifferent between the PIF program and a traditional student loan and the series would be a scalar multiple of the student's series of average incomes.

We recommend calculating, for each category of students, the proportion of the students in that category who will be above the break-even income, applying the assumed share of above-break-even income students who will not participate, and calculating the expected future average incomes of the remaining students in that category and using those adjusted average incomes to forecast cash flows for the program.

We recommend implementing separate calculations of tuition and contributions for each category of student (number of years enrolled by attainment), making use of the additional inputs described above and not combining them until near the end of the process in the appropriate program tab.

While these recommended enhancements would add some complexity to the model, we believe they would overcome an important limitation of the current model and enhance the user's confidence in the reliability of its results. The current model does not allow for participants to follow any path other than exactly four or two years at a participating institution and one year of deferral afterward. Policy may intend for additional years of deferral for those who go on to graduate school. The current model also does not allow those who start in the community college program to move into the four-year program, which policy may intend to allow.