RESEARCH ARTICLE

Tuition reduction is the key factor determining tax burden of graduate students under the Tax Cuts and Job Act [version 1; peer review: 1 approved, 1 approved with reservations]

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Abstract

Background: The proposed Tax Cuts and Jobs Act (H.R.1) has stirred significant public debate on the future of American economics. While supporters of the plan have championed it as a necessity for economic revitalization, detractors have pointed out areas of serious concern, particularly for low- and middle-income Americans. One particularly alarming facet of the plan is the radical change to education finance programs and taxation of students in higher education.

Methods: By analyzing actual income and tuition of a public and a private university student, as well as the 'average' graduate student, we investigated the effect of both the House and Senate versions of H.R. 1 on taxation of students of various family structures.

Results: Our findings indicate that taxable tuition would be the greatest contributor to graduate student tax burden across all four categories of filing status. However, when tuition reduction is upheld or a student is on sustaining fees rather than full tuition, graduate students would realize decreases in taxation.

Conclusions: Overall, we conclude that removal of tuition reduction would result in enormous tax burdens for graduate students and their families and that these effects are dependent not only on the status of the student in their degree program but also on their tuition and stipend, and therefore the institution they attend.

Keywords

higher education, graduate students, tax reform, taxes, tuition reduction

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Introduction

As the Tax Cuts and Jobs Act (H.R.1) inches nearer to becoming law, graduate student concern is mounting to an all-time high. This bill contains changes to how various facets of education are taxed, including student loan interest, education assistance, tax credits, and debt forgiveness¹. However, the most jarring change for graduate students is the removal of tuition reduction², the provision in current tax code allowing students to exclude tuition write-offs from their school from their taxable income. Students are self-reporting that this would increase their yearly taxes between two- and four-fold, resulting in effective tax rates upwards of 33%^{1,3-7}. However, self-reporting can be misleading without in-depth tax calculations included for verification. To address these issues and to help graduate students and elected officials better inform themselves on the impact of proposed tax reform, we analyzed the historical taxes of two graduate students, one public university student and one private university student (the authors of this work). We then extrapolated these analyses for family structures typical of graduate students, including relevant historical and proposed tax deductions and exemptions.

Methods

Tax calculation notes: Because the Senate version of the Tax Cuts and Jobs act is not yet finalized, we used the “Chairman’s Mark” tax brackets for our calculations⁸. We excluded the Additional Child Tax Credit from our analyses because this requires more nuanced calculation of tax before it can be determined and is therefore more complex than is appropriate for this simplified, generic example⁹.

Estimating the ‘average’ graduate student: We estimated the ‘average’ stipend using the current Glassdoor approximation of \$30,603¹⁰ and then back-calculated for 2013–2015 assuming a 2% yearly increase, as was observed in the public and private student stipends. Tuition was calculated using approximate average public graduate school tuition (\$30,000) and average private graduate school tuition (\$40,000)¹¹. Then, we weighted the proportion based on an American Academy of Sciences approximation that 60% of PhDs are awarded from public universities¹². This gave an average tuition across all students of \$34,000 for 2016, which was then back-calculated for 2013–2015 assuming a 2% yearly increase. For health waivers, there is currently no conglomeration of public data available of the average worth provided by universities, so the value used was the average of the public and private student’s actual health waivers (\$1,500).

Cumulative differential tax burden (CDTB): This value was calculated using the sum of TTO for 2013–2016 under each proposed tax plan (House, House with Tuition Reduction, Senate) minus the sum of TTO for 2013–2016 under historical tax structure. The result is four-year TTO for each filing status (single, single with one child, married, married with one child) under each proposed tax plan.

Results

Single individuals represent the largest category of graduate students (approximately 44.41%¹³). Table 1 exhibits the calculated

taxes for the period 2013–2016 for one individual each from a public and private university using historical tax structure^{14–19}, the House proposed plan²⁰, and the Senate proposed plan^{8,21}. These calculations were made using income, tuition, health waivers, the standard deduction (typical for graduate students), and deductions and exemptions that are germane to this group. Representation of the total taxes owed (TTO) and effective tax rates (ETR = TTO / stipend) are shown in Table 1, showing maximum increases under the House plan of approximately +386% and +19%, respectively. For the public student, this jump in both categories can partly be attributed to a low initial tax burden that is substantially increased when tuition is considered taxable income. The increases are more modest in years where this student was on sustaining fees (2015 and 2016) rather than full tuition. When considering the Senate plan, which does not tax tuition²², there are actually large decreases in TTO and modest decreases in ETR (maximum of approximately -29% and -1.75%, respectively). Interestingly, when considering the House plan without taxable tuition, the TTO and ETR both decrease as well (maximum of approximately -14.5% and -1.0%, respectively). This highlights the extreme effect this one change would have on graduate student tax burden.

The results for the student from a private university are similar to those above (Table 1). The House plan results in approximate maximum increases of +192% TTO and +19% ETR, while both the House plan that retains tuition reduction and the Senate plan result in decreased TTO and ETR (approximate maximum of -18.5% TTO and -1.75% ETR for the House plan without taxable tuition; -24% TTO and -2.5% ETR for Senate plan). This student also went from full tuition to sustaining between 2015 and 2016, explaining the modest decrease in TTO and ETR.

Figure 1 shows, in U.S. Dollars (USD), the TTO for single individuals from a public (A) and a private (B) university based upon the type of tax plan applied. For the public student, TTO increases under the House plan, and decreases under the House plan with tuition reduction and the Senate plan (Figure 1A). When tuition is taxed and the student is on full tuition, the TTO increases from \$872 to \$4238 in 2013 and from \$907 to \$4380 in 2014. For the private school student, who was on full tuition from 2013–2015, the increases in TTO under the House plan are \$3,388 to \$9,550 in 2013, \$3,574 to \$10,201 in 2014, and \$3,649 to \$10,669 in 2015 (Figure 1B). Also, similar to the public student calculations, when the private student transitioned to sustaining fees in 2016, they would realize a decreased TTO under the House plan (-\$213), although this decrease would be even greater without taxable tuition and with the Senate plan (-\$623 and -\$813, respectively). Overall, these analyses indicate that the proposed tax plans would generally decrease a single graduate student’s tax burden unless tuition is treated as taxable income, in which case there would be huge increases in TTO.

The changing status and income of graduate students over their programs and the effect this has on taxation is worth noting. Students go on and off of fellowships, affecting the amount and duration of their pay. The public student’s stipend was guaranteed for nine months of the year, but when funded by an outside

Table 1. Calculation of 2013–2016 taxes for single, graduate student taxpayers using historical and proposed tax plans.

	Public Student (Single)				Private Student (Single)			
Total Taxes Owed (TTO)	2013	2014	2015*	2016*	2013	2014	2015	2016*
Historical	\$872.45	\$907.23	\$952.09	\$1,976.25	\$3,387.75	\$3,573.75	\$3,648.75	\$3,736.55
House	\$4,238.34	\$4,380.16	\$1,211.67	\$2,175.32	\$9,550.13	\$10,200.63	\$10,669.13	\$3,523.68
House w/Reduction	\$746.94	\$806.68	\$866.67	\$1,700.00	\$2,767.20	\$2,940.00	\$3,024.00	\$3,114.00
Senate	\$622.45	\$672.23	\$722.23	\$1,509.50	\$2,576.70	\$2,749.50	\$2,833.50	\$2,923.50
Effective Tax Rate (ETR)	2013	2014	2015	2016*	2013	2014	2015	2016*
Historical	4.66%	4.72%	4.83%	7.41%	9.53%	9.66%	9.68%	9.72%
House	22.64%	22.79%	6.14%	8.16%	26.86%	27.57%	28.30%	9.16%
House w/Reduction	3.99%	4.20%	4.39%	6.37%	7.78%	7.95%	8.02%	8.10%
Senate	3.32%	3.50%	3.66%	5.66%	7.25%	7.43%	7.52%	7.60%
% Change from Historical TTO	2013	2014	2015	2016*	2013	2014	2015	2016*
House	385.80%	382.80%	27.26%	10.07%	181.90%	185.43%	192.41%	-5.70%
House w/Reduction	-14.39%	-11.08%	-8.97%	-13.98%	-18.32%	-17.73%	-17.12%	-16.66%
Senate	-28.66%	-25.90%	-24.14%	-23.62%	-23.94%	-23.06%	-22.34%	-21.76%
Difference from Historical ETR	2013	2014	2015	2016*	2013	2014	2015	2016*
House	17.98%	18.07%	1.32%	0.75%	17.33%	17.91%	18.62%	-0.55%
House w/Reduction	-0.67%	-0.52%	-0.43%	-1.04%	-1.75%	-1.71%	-1.66%	-1.62%
Senate	-1.34%	-1.22%	-1.17%	-1.75%	-2.28%	-2.23%	-2.16%	-2.11%

*student on sustaining status

Figure 1. Effect of proposed tax plans on total taxes owed by single graduate students using tax data from 2013–2016. Total Taxes Owed (TTO) represented in USD for single filing public (A) and private (B) university graduate students. TTO for each year (2013–2016) are color coded by year and grouped according to the tax structure utilized to make each calculation (Table 1). These structures were the historical taxation structures for years 2013–2016, the proposed House tax plan, the proposed House plan with Tuition Reduction, and the proposed Senate tax plan. Above each bar is the calculated Effective Tax Rate (ETR) for each scenario, represented as a percent of income.

(e.g., NSF) fellowship, the stipend was year-long, leading to greater annual income when on fellowship. And in later years of their degree, many students no longer have traditional tuition costs, but rather pay sustaining fees, greatly reducing their effective income under the House plan. In **Figure 1A**, the TTO of the public student responds to these fluctuating statuses under each plan. In 2013 and 2014, this student was off of fellowship and on full tuition, then went off of full tuition for 2015 and 2016, and in 2016 was on fellowship. Between 2014 and 2015, the transition to sustaining fees has little effect on plans that do not tax tuition, but under the House plan there is a large decrease (-\$3,168), though this plan still results in an increase as compared to the others (+\$260 vs. historical taxation). This highlights that sustaining fee status greatly reduces the effect of the House tax plan on graduate student tax increases. When the student goes onto fellowship in 2016 their stipend increases, with a concomitant increase in taxation. However, the increase in taxes under the House plan vs. the historical structure remains low (+\$199), exhibiting that an increase in stipend (~30% in this case) has minimal effect on taxation as compared to that of taxing tuition.

While the above data represent the major population of graduate students, they do not paint the whole picture of tax scenarios as a graduate student. We identified three other common family structures of graduate students and calculated taxes for each based on historical and proposed tax policies. These groups and their proportion of the graduate student population were: Single with dependents (12.30%), married without dependents (14.95%), and married with dependents (28.34%)¹³. It is important to mention that in keeping with the subject of this study, namely, graduate students, married couple calculations assume that both partners are students at the same university, and therefore the income, tuition, and health waivers are double that of a single student. Another factor that we controlled for simplicity of calculations was to assume that families that have children only had one.

Table 2 contains the tax calculations for each of the above-mentioned groups using historical and proposed tax structures. Similar to single filers, the House plan would increase graduate student taxes across the board when tuition is considered as taxable. For the public student, TTO and ETR would increase an

Table 2. Calculation of 2013–2016 taxes for graduate student taxpayers with children and/or spouses filing jointly using historical and proposed tax plans.

Single + Child								
	Public				Private			
Total Taxes Owed (TTO)	2013	2014	2015*	2016*	2013	2014	2015	2016*
Historical	\$197.45	\$222.23	\$247.23	\$926.66	\$1,184.00	\$1,352.50	\$1,410.00	\$1,495.00
House	\$1,906.34	\$2,048.16	\$0.00	\$0.00	\$6,425.13	\$7,075.63	\$7,544.13	\$1,191.68
House w/Reduction	\$0.00	\$0.00	\$0.00	\$0.00	\$435.20	\$608.00	\$692.00	\$782.00
Senate	\$0.00	\$0.00	\$0.00	\$0.00	\$576.70	\$749.50	\$833.50	\$923.50
Effective Tax Rate (ETR)	2013	2014	2015*	2016*	2013	2014	2015	2016*
Historical	1.05%	1.16%	1.25%	3.47%	3.33%	3.66%	3.74%	3.89%
House	10.18%	10.66%	0.00%	0.00%	18.07%	19.12%	20.01%	3.10%
House w/Reduction	0.00%	0.00%	0.00%	0.00%	1.22%	1.64%	1.84%	2.03%
Senate	0.00%	0.00%	0.00%	0.00%	1.62%	2.03%	2.21%	2.40%
% Change from Historical TTO	2013	2014	2015*	2016*	2013	2014	2015	2016*
House	865.49%	821.63%	-100.00%	-100.00%	442.66%	423.15%	435.04%	-20.29%
House w/Reduction	-100.00%	-100.00%	-100.00%	-100.00%	-63.24%	-55.05%	-50.92%	-47.69%
Senate	-100.00%	-100.00%	-100.00%	-100.00%	-51.29%	-44.58%	-40.89%	-38.23%
Difference from Historical ETR	2013	2014	2015*	2016*	2013	2014	2015	2016*
House	9.13%	9.50%	-1.25%	-3.47%	14.74%	15.47%	16.27%	-0.79%
House w/Reduction	-1.05%	-1.16%	-1.25%	-3.47%	-2.11%	-2.01%	-1.90%	-1.85%
Senate	-1.05%	-1.16%	-1.25%	-3.47%	-1.71%	-1.63%	-1.53%	-1.49%

*student on sustaining status

Married Filing Jointly								
	Public				Private			
Total Taxes Owed (TTO)	2013	2014	2015*	2016*	2013	2014	2015	2016*
Historical	\$1,744.90	\$1,814.46	\$1,904.18	\$3,967.49	\$6,775.50	\$7,147.50	\$7,297.50	\$7,502.50
House	\$4,985.28	\$5,186.84	\$2,078.35	\$3,875.31	\$10,159.20	\$10,644.24	\$11,119.00	\$6,637.68
House w/Reduction	\$1,493.88	\$1,613.36	\$1,733.35	\$3,399.99	\$5,534.40	\$5,880.00	\$6,048.00	\$6,228.00
Senate	\$1,244.90	\$1,344.46	\$1,444.46	\$3,018.99	\$5,153.40	\$5,499.00	\$5,667.00	\$5,847.00
Effective Tax Rate (ETR)	2013	2014	2015*	2016*	2013	2014	2015	2016*
Historical	4.66%	4.72%	4.83%	7.44%	9.53%	9.66%	9.68%	9.76%
House	13.31%	13.49%	5.27%	7.27%	14.28%	14.38%	14.75%	8.63%
House w/Reduction	3.99%	4.20%	4.39%	6.37%	7.78%	7.95%	8.02%	8.10%
Senate	3.32%	3.50%	3.66%	5.66%	7.25%	7.43%	7.52%	7.60%
% Change from Historical TTO	2013	2014	2015*	2016*	2013	2014	2015	2016*
House	185.71%	185.86%	9.15%	-2.32%	49.94%	48.92%	52.37%	-11.53%
House w/Reduction	-14.39%	-11.08%	-8.97%	-14.30%	-18.32%	-17.73%	-17.12%	-16.99%
Senate	-28.66%	-25.90%	-24.14%	-23.91%	-23.94%	-23.06%	-22.34%	-22.07%
Difference from Historical ETR	2013	2014	2015*	2016*	2013	2014	2015	2016*
House	8.65%	8.77%	0.44%	-0.17%	4.76%	4.73%	5.07%	-1.12%
House w/Reduction	-0.67%	-0.52%	-0.43%	-1.06%	-1.75%	-1.71%	-1.66%	-1.66%
Senate	-1.34%	-1.22%	-1.17%	-1.78%	-2.28%	-2.23%	-2.16%	-2.15%

*student on sustaining status

Married Filing Jointly + Child								
	Public				Private			
Total Taxes Owed (TTO)	2013	2014	2015*	2016*	2013	2014	2015	2016*
Historical	\$1,354.90	\$1,419.46	\$1,484.46	\$3,359.99	\$5,190.50	\$5,555.00	\$5,697.50	\$5,895.00
House	\$3,385.28	\$3,586.84	\$478.35	\$2,275.31	\$8,559.20	\$9,044.24	\$9,519.00	\$5,037.68
House w/Reduction	\$0.00	\$13.36	\$133.35	\$1,799.99	\$3,934.40	\$4,280.00	\$4,448.00	\$4,628.00
Senate	\$0.00	\$0.00	\$0.00	\$1,018.99	\$3,153.40	\$3,499.00	\$3,667.00	\$3,847.00
Effective Tax Rate (ETR)	2013	2014	2015*	2016*	2013	2014	2015	2016*
Historical	3.62%	3.69%	3.76%	6.30%	7.30%	7.51%	7.56%	7.67%
House	9.04%	9.33%	1.21%	4.27%	12.03%	12.22%	12.62%	6.55%
House w/Reduction	0.00%	0.03%	0.34%	3.37%	5.53%	5.78%	5.90%	6.02%
Senate	0.00%	0.00%	0.00%	1.91%	4.43%	4.73%	4.86%	5.00%
% Change from Historical TTO	2013	2014	2015*	2016*	2013	2014	2015	2016*
House	149.85%	152.69%	-67.78%	-32.28%	64.90%	62.81%	67.07%	-14.54%
House w/Reduction	-100.00%	-99.06%	-91.02%	-46.43%	-24.20%	-22.95%	-21.93%	-21.49%
Senate	-100.00%	-100.00%	-100.00%	-69.67%	-39.25%	-37.01%	-35.64%	-34.74%
Difference from Historical ETR	2013	2014	2015*	2016*	2013	2014	2015	2016*
House	5.42%	5.64%	-2.55%	-2.03%	4.74%	4.72%	5.07%	-1.11%
House w/Reduction	-3.62%	-3.66%	-3.43%	-2.92%	-1.77%	-1.72%	-1.66%	-1.66%
Senate	-3.62%	-3.69%	-3.76%	-4.39%	-2.86%	-2.78%	-2.69%	-2.66%

*student on sustaining status

approximate maximum of +866% / +9.5% as a single filer with one child, +188% / +8.8% as a married couple filing jointly, and +385% / +5.7% as a married couple filing jointly with one child. In all cases, when tuition is not taxed in proposed plans, decreases in TTO and ETR are observed as compared to historical tax structures. Approximate maximum decreases in TTO and ETR under the Senate plan are -29% / -1.8% for Married Filing Jointly (MFJ) and -29% / -4.5% for MFJ with one child. The House plan without taxable tuition has similar, albeit more modest decreases in TTO and ETR (MFJ = -14.5% / -1.1%; MFJ with one child = -14.5% / -3.7%). Strikingly, the single filer with one child would actually owe no taxes to the government for any year if tuition is not taxable.

The private student would encounter similar tax scenarios, with approximate maximum increases in TTO and ETR under the House plan of +443% / +16.3% as a single with one child, +52.4% / +5.1% as MFJ, and +67.1% / +5.07% as MFJ with one child. Removal of taxable tuition results in decreased taxation in all cases, with the House plan performing better for singles with one child

(-63.25% / -2.15%) and the Senate plan performing better for married filers (MFJ = -24% / -1.75%; MFJ with one child = -39.25% / -1.8%).

Figure 2 shows the range of TTO in USD for the various family structures of graduate students from a public (A) and a private (B) university based upon the type of tax plan applied. When tuition is taxed under the House plan, TTO increases in all cases for all filers. For the public student these increases were greatest with 2014 data (single with one child = \$222 to 2,048; MFJ = \$1,814 to \$5,187; MFJ with one child = \$1,419 to \$3,587), the last year this student was on full tuition (Figure 2A). When calculations were made using the House plan without taxable tuition and/or the Senate plan, TTO decreased in all cases. And when the student was no longer on full tuition (2015 and 2016) TTO actually decreased when comparing the House plan with the historical structure in all cases (with the exception of MFJ in 2015). In 2015, these changes were: Single = -\$260; single with one child = -\$247; MFJ = +\$174; MFJ with one child = -\$1,006. In 2016, these changes were: Single = -\$199;

Figure 2. Effect of proposed tax plans on total taxes owed by graduate student taxpayers with children and/or spouses filing jointly using tax data from 2013–2016. Total Taxes Owed (TTO) represented in USD for public (A) and private (B) university graduate students filing either as single with one child, married (filing jointly), or married with one child (filing jointly). TTO for each year (2013–2016) are color coded by year and grouped according to the tax structure utilized to make each calculation (Table 2). These structures were the historical taxation structures for years 2013–2016, the proposed House tax plan, the proposed House plan with Tuition Reduction, and the proposed Senate tax plan. A “0” represents no taxes owed.

single with one child = -\$927; MFJ = -\$92; MFJ with one child = -\$1,085.

The increase in TTO was also largest for the private school student in the last year of full tuition, 2015 (single with one child = \$1,410 to 7,544; MFJ = \$7,298 to \$11,119; MFJ with one child = \$5,698 to \$9,519) (Figure 2B). For all family types and in all cases, when the private school student was no longer on full tuition or when calculations were made using proposed plans without taxable tuition, there were decreases in TTO, though these were most striking for couples (ex.: 2016, MFJ with one child: Historical = \$5,895; House = \$5,038, [-\$857]; House without taxable tuition = \$4,628, [-\$1,267]; Senate = \$3,847, [-\$2,048]). Overall, these analyses indicate that the proposed tax plans would generally decrease graduate student family tax burden unless tuition is treated as taxable income. Both new plans benefit students in the form of decreased taxation when they are on sustaining fees near the end of their degrees. Additionally, the Senate plan results in more tax relief than any other tax structure for all family types.

While utilizing taxes from representative students is useful to delineate between type of institution, it is more generally applicable to analyze the average income, tuition, and health waiver of a typical graduate student. These calculations (Dataset 3) follow the same trends as those for the individuals above, and the effect of various tax plans on TTO are shown below in Figure 3. Increases in TTO under the House plan were most drastic using 2016 estimates (single = \$2,566 to \$7,550; single with one child = \$320 to \$4,425; MFJ = \$5,148 to \$8,604; MFJ with one child = \$3,540 to \$7,004). As before, removal of taxable tuition from the House plan and/or the Senate plan results in overall decreases in TTO (Example, 2016, single: Historical = \$2,566; House without taxable tuition = \$2,172, [-\$394]; Senate = \$1,982, [-\$584]).

The cumulative effect of tax reform on graduate students is likely the most informative measure of potential impacts. In Figure 4, we calculate the cumulative difference in taxes over four years with both former and proposed tax plans for the public student (A), private student (B), and average student (C). For the public student, the cumulative differential tax burden (CDTB, see Methods) over four years under the House tax plan is \$7,297 for a single filer and \$2,107 for a single with one child (Figure 4A). These figures are marginally lower for married filers (\$6,695 to \$2,361), as expected. These results highlight that, under the House plan, dependent child status has a greater buffering impact than does marriage. For the private student, whose stipend and tuition are greater than the public student, the CDTB values are: Single = \$19,597; single with one child = \$16,795; MFJ = \$9,837; MFJ with one child = \$9,822 (Figure 4B). For single and single with one child, these tax increases are equal to approximately one-eighth the student's total stipend income over four years. Interestingly, at higher income and tuition marriage status is the larger buffer, apparently due to a low initial tax burden for those with children at lower incomes. This also proves true for the CDTB of the average graduate student: Single = \$18,451; single with one child = \$14,941; MFJ = \$13,325; MFJ with one child = \$13,310 (Figure 4C). Strikingly, the CDTB is always negative when tuition is not taxable, meaning that the new tax plans would reduce cumulative taxation when compared to the historical structure. These data indicate that graduate students would actually benefit from the House and Senate tax plans in the form of decreased tax burden, as long as tuition is not taxable.

As has been alluded to throughout this work, it would appear that taxation of tuition is the single most important factor affecting graduate students in the House tax plan. In Figure 5, we show the effect of including tuition reduction in the House tax plan for one tax year, using 2016 estimations. For all graduate student

Figure 3. Effect of proposed tax plans on the average graduate student. Total Taxes Owed (TTO) represented in USD for an 'average' university graduate student filing either as single, single with one child, married (filing jointly), or married with one child (filing jointly). TTO for each year (2013–2016) are color coded by year and grouped according to the tax structure utilized to make each calculation (Datasets 1–3, Tables S1–S6). These structures were the historical taxation structures for years 2013–2016, the proposed House tax plan, the proposed House plan with Tuition Reduction, and the proposed Senate tax plan. A "0" represents no taxes owed.

Figure 4. Four-year cumulative taxation for various family types under each tax structure. Cumulative Differential Tax Burden (CDTB) represented in USD for a public university (A), private university (B), or 'average' (C) graduate student. CDTB is the TTO for four years (2013–2016) and is coded by filing status (single, single with one child, married [filing jointly], or married with one child [filing jointly]) and grouped according to the tax structure utilized to make each calculation (Datasets 1–3, Tables S1–S6). These structures were the historical taxation structures for years 2013–2016, the proposed House tax plan, the proposed House plan with Tuition Reduction, and the proposed Senate tax plan.

Figure 5. The effect of tuition reduction on graduate student taxation under the proposed House tax plan. Total Taxes Owed (TTO) in 2016, represented in USD, for an 'average' university graduate student filing either as single, single with one child, married (filing jointly), or married with one child (filing jointly). Data are coded according to the tax structure utilized to make each calculation (Datasets 1–3, Tables S1–S6). These structures were the proposed House tax plan and the proposed House plan with Tuition Reduction. A "0" represents no taxes owed.

family structures, changing this single factor immensely decreases the tax burden in all cases, anywhere from -\$4,260 (MFJ with one child) to -\$5,378 (single). This is a larger decrease than is realized for marriage (-\$3,248 per person), having a child (-\$3,125), or even the combination of these two (-\$4,048 per person).

Dataset 1. Calculation of 2013–2016 taxes for a public university graduate student using historical tax plans

<http://dx.doi.org/10.5256/f1000research.13385.d188156>

Dataset 2. Calculation of 2013–2016 taxes for a private university graduate student using historical tax plans

<http://dx.doi.org/10.5256/f1000research.13385.d188157>

Dataset 3. Calculation of 2013–2016 taxes for the ‘average’ university graduate student using historical tax plans

<http://dx.doi.org/10.5256/f1000research.13385.d188158>

Discussion

In this work, it was our goal to better understand the effects of the proposed Tax Cuts and Jobs Act on graduate students and to provide accurate information to help students, their supporters, and elected officials make informed decisions in their stand on the matter. Our findings indicate that taxable tuition would be the greatest contributor to graduate student tax burden across all four categories of filing status. However, when tuition is removed from the equation (whether in our modified House plan, the Senate plan, or by transition of students to sustaining fees) there is a decrease in tax burden in all situations. This gives validity to claims that these new tax plans would generally benefit low and middle-income families in the form of reduced taxation, at least in the short term^{23,24}. But for graduate students, it would appear that these benefits would not be realized if tuition is considered taxable income.

Overall, we conclude that exclusion of tuition reduction from H.R.1, or for that matter any future iteration of U.S. Tax Code,

would be an enormous financial burden on graduate students. What this would mean for graduate education in the US is uncertain, but will likely impact what schools will be able to host graduate programs, who can afford graduate education, and the diversity of the students within graduate programs.

Data availability

Data for the two graduate student tuitions, stipends, and health waivers were provided directly from the authors from their personal tax information. These values can be found in the respective columns in **Dataset 1** and **Dataset 2**.

Values used to calculate the ‘average’ graduate student were obtained via Glassdoor¹⁰, MoneyUnder30¹¹, and the American Academy of Sciences¹² (see Methods) or estimated from the mean of the two student values available in the absence of available data on health waivers and can be found in **Dataset 3**. All data is publicly available.

Dataset 1. Calculation of 2013–2016 taxes for a public university graduate student using historical tax plans. DOI, <http://dx.doi.org/10.5256/f1000research.13385.d188156>²⁵

Dataset 2. Calculation of 2013–2016 taxes for a private university graduate student using historical tax plans. DOI, <http://dx.doi.org/10.5256/f1000research.13385.d188157>²⁶

Dataset 3. Calculation of 2013–2016 taxes for the ‘average’ university graduate student using historical tax plans. DOI, <http://dx.doi.org/10.5256/f1000research.13385.d188158>²⁷

Competing interests

No competing interests were disclosed.

Grant information

The author(s) declared that no grants were involved in supporting this work.

Supplementary material

Table S1. Calculation of 2013–2016 taxes for a public university graduate student using the proposed House tax plan, with and without tuition reduction.

[Click here to access the data.](#)

Table S2. Calculation of 2013–2016 taxes for a private university graduate student using the proposed House tax plan, with and without tuition reduction.

[Click here to access the data.](#)

Table S3. Calculation of 2013–2016 taxes for the ‘average’ university graduate student using the proposed House tax plan, with and without tuition reduction.

[Click here to access the data.](#)

Table S4. Calculation of 2013–2016 taxes for a public university graduate student using the proposed Senate tax plan.
[Click here to access the data.](#)

Table S5. Calculation of 2013–2016 taxes for a private university graduate student using the proposed Senate tax plan.
[Click here to access the data.](#)

Table S6. Calculation of 2013–2016 taxes for the ‘average’ university graduate student using the proposed Senate tax plan.
[Click here to access the data.](#)

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Elizabeth Garrett-Mayer

Division Director, Biostatistics and Data Management, American Society of Clinical Oncology (ASCO), Alexandria, VA, USA

Page 3: What is TTO? Not defined prior to its introduction in the Methods. It is defined in the Results instead.

Assumptions regarding income, health waivers and stipends are not well-described. In table 1, what income level is this based on? In the results, it is stated that "this student" is on sustaining fees and not full tuition. How would one know that? The assumptions should be plainly described in the methods section AND in the caption of the table. It seems that the authors are actually following the tax burden of a single graduate student where each year (2013-2016) represents that students year in graduate school. This is not clear at all. The methods need to be substantially improved.

The increase to 386% is misleading. It would seem relevant to calculate change from the most recent year of data, not 2013. The "sustaining" status is not clearly defined. This is obviously critically important. In Table 1, why does 2015 have an asterisk in the top row but not other rows? It would seem more logical and less confusing to take a single year (e.g. 2016) and compare the tax implications for students in each of the different settings. That is, showing the 2016 tax burden under each plan for students with full tuition, sustaining fees, stipend, different levels of other income or filing status, etc. The way it is now, because the methods do not emphasize (nor do most of the figures), it looks like 2013 is very odd.

Why does that stipend double when filing jointly?

There is no actual 'data', but the author provide the numbers on which they based their assumptions. I have serious concerns that the results will be misinterpreted due to the presentation of results.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 02 Feb 2018

Michael Parker, Yale University School of Medicine, New Haven, USA

Thank you for your time in reviewing our manuscript and for your insight and suggestions. We address each comment and suggestion in the order presented and hope that the edits in Version 2 meet your expectations.

The original comments are shown in bold type font and our responses in regular font. Where changes have been made to the manuscript, the relevant text has been copied and pasted here and is shown within quotation marks.

Reviewer comment 1:

Page 3: What is TTO? Not defined prior to its introduction in the Methods. It is defined in the Results instead.

Authors response 1:

We have added a paragraph devoted to TTO in the Methods section. It now reads as follows:

“Total taxes owed (TTO): For each year 2013–2016, the appropriate tax brackets were applied to calculate the total taxes owed (TTO) based on stipends, health waivers, and tuition. Representation of TTO is calculated by year, and differences in TTO for each proposed tax structure are in relation to that same year’s historical tax structure TTO calculation. The income values used for these calculations as well as the numerous factors considered in tax calculations (i.e., column headers) can all be found in Datasets 1–3.”

Reviewer comment 2a:**Assumptions regarding income, health waivers and stipends are not well-described.**

Authors response 2a:

To more fully describe the income, health waiver, and stipend, additional information was added to the new TTO paragraph in the Methods as cited above. For the single public and private university students, no assumptions are made; rather the self-reported data by each student is used as provided. Assumptions for the 'average' grad student are given under the title subtitle 'Estimating the average graduate student' in the Methods section.

Reviewer comment 2b:**In table 1, what income level is this based on?**

Authors response 2b:

For the Historical, House w/tuition reduction, and Senate scenarios, the income level used to calculate the tax burden in Table 1 is the student stipend only. Under the House plan, the income level is the sum of the stipend, health waiver, and tuition amounts as all three would be considered taxable income. The supplementary tables, S1-S6, include the exact stipend, health waiver, and tuition amounts for each student and each year.

Reviewer comment 2c:

In the results, it is stated that "this student" is on sustaining fees and not full tuition. How would one know that? The assumptions should be plainly described in the methods section AND in the caption of the table. It seems that the authors are actually following the tax burden of a single graduate student where each year (2013-2016) represents that students year in graduate school. This is not clear at all. The methods need to be substantially improved.

Authors response 2c: An additional paragraph has been added to the methods section detailing the unique position of sustaining status. It reads as follows:

"Sustaining fees: Once graduate students progress from the class and teaching portions of their graduate work into the research intensive/exclusive portion, many schools no longer charge full tuition, but rather a smaller fee termed a "sustaining fee". In the case of both graduate student salaries utilized in this work, this was the case, and the sustaining fees for each can be found in Datasets 1 and 2. The public student was on sustaining status in 2015 and 2016 while the private student was on sustaining status in 2016. The reduction in taxation is drastic when students transition from tuition status to sustaining status under plans that do not contain the tuition reduction provision (see Figures 1 and 2)."

In addition, the introduction section has been revised to more clearly state that the years cited are in fact the progression of each graduate student through PhD programs:

"To address these issues and to help graduate students and elected officials better inform themselves on the impact of proposed tax reform, we analyzed the historical taxes of two graduate students, one public university student and one private university student (the authors of this work), over the course of four years (2013-2016) in science PhD programs."

Additionally, the caption of Table 1 had been revised as suggested to note the sustaining

status and that the numbers can be found in the supplementary tables.

Reviewer comment 3a:

The increase to 386% is misleading. It would seem relevant to calculate change from the most recent year of data, not 2013.

Author response 3a: The 'historical' taxes are those that have been paid by each student in each year of graduate study (2013-2016), and serves essentially as the 'control' case. Thus, the differences (both absolute and percent change) use the 'historical' tax owed in the respective year as the reference value when calculating the changes under each plan. For example, the public student filing singly in 2013 owed \$872, as the student's stipend (and therefore gross income) was \$18,724. If the House plan had been in effect at that time, the student's gross income would have instead been the sum of the student's stipend, health waiver (\$1,273), and tuition waiver (\$27,822), bringing the student's gross income for 2013 to \$47,819. Therefore, the student would have owed \$4,238 in taxes in 2013, if the House plan had been in effect; an increase of 385% over the historical tax burden. We use this retrospective analysis approach to quantify the potential each of the proposed plans on graduate student tax burden.

Reviewer comment 3b:

The "sustaining" status is not clearly defined. This is obviously critically important. In Table 1, why does 2015 have an asterisk in the top row but not other rows?

Authors' response 3b:

Thank you for calling the ambiguity related to sustaining fees to our attention, which was echoed by the second reviewer. As a result of these comments, we've revised the Methods section to include an additional paragraph which describes the sustaining fees/status. It now reads as follows:

"Sustaining fees: Once graduate students progress from the class and teaching portions of their graduate work into the research intensive/exclusive portion, many schools no longer charge full tuition, but rather a smaller fee termed a "sustaining fee". In the case of both graduate student salaries utilized in this work, this was the case, and the sustaining fees for each can be found in Datasets 1 and 2. The public student was on sustaining status in 2015 and 2016 while the private student was on sustaining status in 2016. The reduction in taxation is drastic when students transition from tuition status to sustaining status under plans that do not contain the tuition reduction provision (see Figures 1 and 2)."

With respect to the asterisk in the top row, this was supposed to be included for the 2015 headers for the public student but erroneously excluded. Thank you for bringing it to our attention. We have updated Table 1 to fix this issue.

Reviewer comment 3c:

It would seem more logical and less confusing to take a single year (e.g. 2016) and compare the tax implications for students in each of the different settings. That is, showing the 2016 tax burden under each plan for students with full tuition, sustaining fees, stipend, different levels of other income or filing status, etc. The way it is now, because the methods do not emphasize (nor do most of the figures), it looks like 2013

is very odd.

We agree that presenting the data in the way suggested would more clearly display the impacts of each plan on the respective categories listed. However, a main goal of this work was to better understand the cumulative impacts of these potential plans over the course of a graduate student's career; a career that is not typically not limited to any one of these settings (e.g., full tuition, sustaining, etc.) but rather is an aggregate of each of these and other factors that change yearly. Thus, we feel it provides a distinct advantage and is more representative to display the data in the way chosen. For example, Fig. 1 shows that despite the yearly variability in taxes owed, especially for the public university student (due to a 2016 increased stipend), the House plan greatly increases the tax burden for both students. However, the House plan with the tuition reduction maintained and the Senate plan both decrease the tax burden for both students.

Reviewer comment 4:

Why does that stipend double when filing jointly?

Although the majority of graduate students are unmarried, we acknowledge that other family structures exist and these structures could be particularly vulnerable to drastic changes in the tax code. Thus, we extended the analysis to consider single graduate students with one child, married graduate students, and married graduate students with one child. As this analysis is centered specifically on graduate students, we consider only marriages where the couple is comprised of two graduate students at the same university. As a result, the income for the couple is defined as twice the individual student's yearly stipend. We acknowledge that a married graduate student could be married to any variety of partners, and thus why we limit the analysis to only graduate student pairs.

This is described in paragraph 5 of the results:

"It is important to mention that in keeping with the subject of this study, namely, graduate students, married couple calculations assume that both partners are students at the same university, and therefore the income, tuition, and health waivers are double that of a single student."

Reviewer comment 5:

There is no actual 'data', but the author provide the numbers on which they based their assumptions. I have serious concerns that the results will be misinterpreted due to the presentation of results.

Author response 5:

The data provided are the actual student stipends, health waiver amounts, and tuition costs for four years for two graduate students – one at a public university and one at a private university. These data are taken directly from pay stubs and student financial statements willingly disclosed by the students; the authors of this manuscript. Although it would be ideal to have a large sample size of student financial information, we feel it is not necessary for the scope of this work. As public universities tend to offer lower stipends and private universities typically the highest, the public v. private university contrast offers lower and

upper bounds on the potential impacts of each of these plans. This is confirmed by the information obtained from Glassdoor that shows the average stipend for a graduate student falls between that reported by the public and private university students.

We hope that the explanations provided in these responses and the changes to the manuscript made as a result of the thoughtful reviewer comments have helped to clarify the data and assumptions and have generally improved the presentation of the manuscript.

Competing Interests: No competing interests were disclosed.

Reviewer Report 23 January 2018

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Joshua D Hall

Office of Graduate Education, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

This well-written article examines the financial impact that changes to the US tax code would have on graduate students who receive paid tuition as a benefit. This is a timely and important topic being discussed by graduate students and those involved with graduate education across the country. While the final, passed tax bill did not include taxation of graduate student tuition benefits, this study will provide useful data for demonstrating the significant financial burden such a change would levy upon graduate students if it comes up for discussion in the future.

A few specific comments and suggestions.

1. As a technical point, the term "tuition reduction" is used to describe the benefit that graduate students would potentially no longer be able to deduct. However, in biomedical graduate programs that I am familiar with, the grad student tuition is not waived or reduced, but paid on behalf of the graduate student by their department or thesis lab. This may be what the authors meant by this term, but this should be clarified to avoid confusion.
2. For estimation of "average" graduate student salaries, it is unclear if this is for graduate students of all disciplines or for students from only STEM disciplines, which tend to have higher stipend levels. The \$30,603 average seems high for an average inclusive of all graduate students independent of discipline.
3. Please define "TTO" the first time it is used.
4. I'm not familiar with the term "sustaining fees". I'm deducing that this means the student did not have to pay tuition for that year for some reason, but this should be defined explicitly in the text, especially because it has a big influence on the results in Table/Figure 1.
5. While individual funding structures for graduate students can vary widely from discipline to

discipline (and even year to year as the data from Fig 1 indicates for individual students), the analysis in Figure 3 is particularly useful for showing the taxation impact on graduate students overall as a result of a taxation plan that includes taxation of tuition benefits.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Biomedical graduate education, microbiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 02 Feb 2018

Michael Parker, Yale University School of Medicine, New Haven, USA

Thank you for your time in reviewing our manuscript and for your insight and suggestions. We address each by the number system you utilized for commenting and hope that the edits in Version 2 meet your expectations.

Reviewer comment 1:

As a technical point, the term "tuition reduction" is used to describe the benefit that graduate students would potentially no longer be able to deduct. However, in biomedical graduate programs that I am familiar with, the grad student tuition is not waived or reduced, but paid on behalf of the graduate student by their department or thesis lab. This may be what the authors meant by this term, but this should be clarified to avoid confusion.

Authors response 1.

Thanks for pointing this out. We edited the wording in the introduction to make it clearer

that this typically refers to tuition paid for the student by department money. This section now reads:

"However, the most jarring change for graduate students is the removal of tuition reduction², the provision in current tax code allowing students to exclude money provided by their graduate program to cover their tuition costs from their taxable income."

Reviewer comment 2:

For estimation of "average" graduate student salaries, it is unclear if this is for graduate students of all disciplines or for students from only STEM disciplines, which tend to have higher stipend levels. The \$30,603 average seems high for an average inclusive of all graduate students independent of discipline.

Authors response 2:

Although we agree that this average seems high, it is the best approximation we can make from anonymous self-reporting. It would appear that the Glassdoor site may have a bias toward STEM fields, but it is not clear. We provided a statement in the methods to note this uncertainty, which hopefully provides more clarity on the nature of the approximation. This revised section reads as follows:

"We estimated the 'average' stipend using the current Glassdoor approximation of \$30,603¹⁰ and then back-calculated for 2013–2015 assuming a 2% yearly increase, as was observed in the public and private student stipends. One consideration in this approximation is that these data are self-reported and not field specified and since STEM fields typically have higher stipends than humanities, bias in either discipline's direction may skew this value."

Reviewer comment 3:

Please define "TTO" the first time it is used.

Authors' response 3:

Done. Additionally, we have added an additional section describing TTO more fully to the methods to address both reviewer comments about TTO.

Reviewer comment 4:

I'm not familiar with the term "sustaining fees". I'm deducing that this means the student did not have to pay tuition for that year for some reason, but this should be defined explicitly in the text, especially because it has a big influence on the results in Table/Figure 1.

Authors' response 4:

Thanks for calling this to our attention. Students are typically placed on sustaining status after they have completed their coursework, but still have other degree requirements to fill. This is most often research and/or the completion of a thesis. Tuition is not charged since the student is not enrolled in classes. Instead a sustaining fee is charged in exchange for the student's active status and to allow continued use of the University resources. We have revised the Methods section to include an additional paragraph which describes the sustaining fees/status. It now reads as follows:

"Sustaining fees: Once graduate students progress from the class and teaching portions of their graduate work into the research intensive/exclusive portion, many schools no longer charge full tuition, but rather a smaller fee termed a "sustaining fee". In the case of both graduate student salaries utilized in this work, this was the case, and the sustaining fees for each can be found in Datasets 1 and 2. The public student was on sustaining status in 2015 and 2016 while the private student was on sustaining status in 2016. The reduction in taxation is drastic when students transition from tuition status to sustaining status under plans that do not contain the tuition reduction provision (see Figures 1 and 2)."

Reviewer comment 5:

While individual funding structures for graduate students can vary widely from discipline to discipline (and even year to year as the data from Fig 1 indicates for individual students), the analysis in Figure 3 is particularly useful for showing the taxation impact on graduate students overall as a result of a taxation plan that includes taxation of tuition benefits.

Authors' response 5:

Thank you for your kind words and for your support of the reasoning behind this figure. We, too, believe that these data are important and hope they will be widely useful for readers of our manuscript.

Competing Interests: No competing interests were disclosed.

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