Impact of the amortization of certain R&D expenditures on R&D spending in the United States

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Executive summary

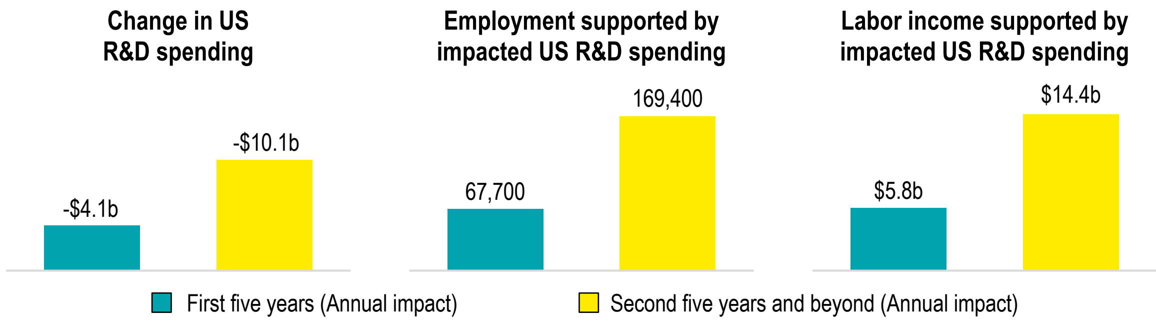
Research and development (R&D) in new technologies and products is an important source of economic growth and higher living standards. Not only do consumers benefit from new technologies, products, and lower prices, workers also benefit from productivity-enhancing innovation that allows companies to create new or higher-paying jobs.

The Tax Cuts and Jobs Act (TCJA) significantly curtailed one of the major tax incentives for R&D: the immediate deductibility of qualifying R&D spending. In particular, the TCJA requires that qualifying R&D conducted in the United States be amortized over 5 years and other qualifying R&D be amortized over 15 years. This change applies to qualifying R&D spending starting in 2022. As a result, the United States will be the only developed country requiring the amortization of R&D expenditures.

Key findings

The requirement to amortize certain R&D expenditures will have significant economic implications. This report presents estimates of the impact of the amortization of R&D expenses on R&D spending and R&D-related jobs and labor income in the United States, and finds that the requirement to amortize certain R&D expenditures will:

- **Reduce R&D spending.** Requiring certain R&D expenditures to be amortized is estimated to reduce US R&D spending by $4.1 billion annually in the first five years and $10.1 billion annually in the second five years and beyond.
- **Reduce jobs.** Requiring certain R&D expenditures to be amortized is estimated to result in a loss of 23,400 US R&D jobs in each of the first five years and 58,600 in each of the second five years and beyond. Including economic activity related to R&D suppliers and consumer spending, the R&D that would otherwise occur if not for the amortization provision supports 67,700 jobs in each of the first five years and 169,400 in each of the second five years and beyond.
- **Reduce labor income**. Requiring certain R&D expenditures to be amortized is estimated to reduce US R&D-related labor income by $3.3 billion annually in the first five years and $8.2 billion annually in the second five years and beyond. Including economic activity related to suppliers and consumer spending, the R&D that would otherwise occur if not for amortization supports $5.8 billion of labor income in each of the first five years and $14.4 billion of labor income in each of the second five years and beyond.



Note: The change in R&D employment is not additive across years. For example, in each of the first five years it is the same 23,400 R&D jobs earning $3.3 billion each year. All impacts are scaled to the size of the US economy in 2018. Source: EY analysis.

Notably, these are high-paying research jobs: In 2017 the average annual wage for R&D-related employment was $134,978 – more than 2.4 times higher than the economy-wide annual average wage. In particular, this report estimates that for every $1 billion of US R&D spending 17,000 jobs earning $1.4 billion are supported in the United States.

Rationale for R&D tax incentives

The benefits from R&D to the broader economy may not be fully recognized by individual firms, but are important to the economy's overall performance, thereby providing the basis for research incentives. Societal benefits from companies' R&D investments can exceed the return received by the private companies making those investments. This can happen when the costs of developing new technologies and products is high and competitors copy the end result. In such cases, companies might invest less in R&D than the level most beneficial to the economy because of what economists refer to as a positive spillover effect that would otherwise accrue to the broader economy. Tax incentives help align companies' incentives for research with their societal benefits.

The requirement to amortize certain R&D expenditures was estimated by the Joint Committee on Taxation to raise $119.2 billion over the 2018-27 10-year budget window and will have significant economic implications.[1]

International context

It is important to recognize that this policy change is occurring in the context of increased global competition for R&D spending. The United States was one of the first nations to enact a tax incentive for R&D, but other nations have since followed suit. The OECD reports that, as of 2018, the United States is ranked 26th out of the 36 OECD nations in the value of R&D tax incentives (e.g., immediate deductibility, credit) provided for R&D. Moreover, the value of the US tax incentive for R&D will decline further when the amortization of qualifying R&D expenditures goes into effect in 2022.

The TCJA requirement to amortize expenses over a period of years will not only impact R&D spending in the United States, but could also impact where companies choose to locate their intellectual property. Economic research generally finds that R&D is responsive to its tax treatment. Companies perform R&D on a global basis. This is often done to enhance and complement US operations, by diversifying research and using talent across the company's operations. Companies that own their intellectual property in the United States would be particularly impacted by the fact that other qualifying R&D expenses must be amortized over 15 years, which could, in turn, impact companies' decisions to locate their intellectual property outside the United States.

Contents

Impact of the amortization of certain R&D expenditures on R&D spending in the United States

I. Introduction

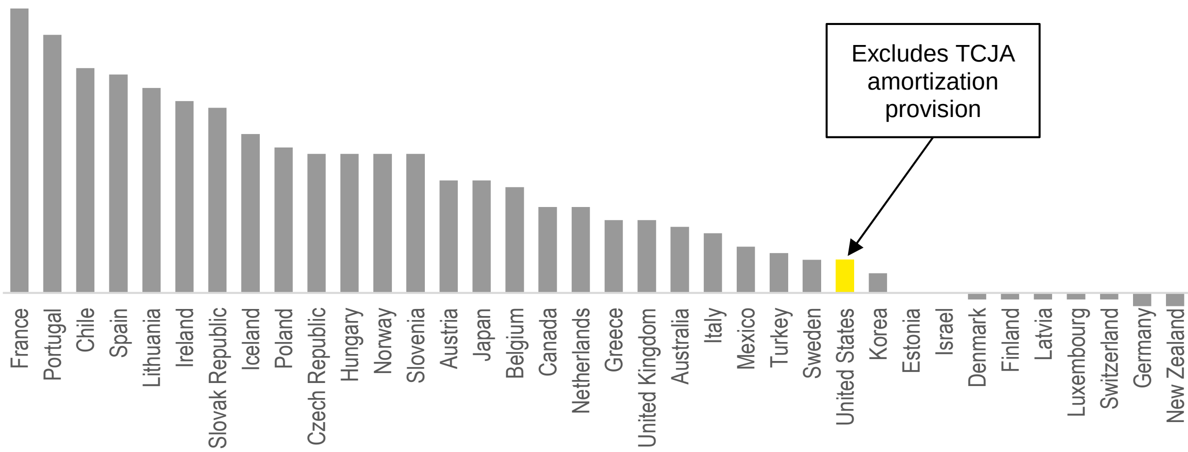
Research and development (R&D) in new technologies and products is an important source of economic growth and higher living standards. Not only do consumers benefit from new technologies, products, and lower prices, workers also benefit from productivity-enhancing innovation that allows companies to create new or higher-paying jobs. The benefits society receives from companies' R&D investments can, however, exceed the return received by the private companies making those investments. This can happen when the costs of developing new technologies and products is high and competitors copy the end result. In such cases, companies might invest less in R&D than the level most beneficial to the economy because of what economists refer to as a positive spillover effects that would otherwise accrue to the broader economy.[2]

One approach to increasing investment in R&D and addressing this issue is through tax incentives, which the United States has employed for several decades. These tax incentives have included allowing the immediate deduction of qualifying R&D expenditures and a tax credit for R&D.[3] The immediate deductibility of qualifying R&D expenditures allows companies to deduct the full value of their costs (in present value) rather than having to capitalize the costs and receive the deductions over the life of the investment. The R&D tax credit allows taxpayers to take a credit of up to 20% of their increased expenditures on qualifying R&D. Together, these policies have been found to increase the amount of R&D conducted by the private sector.[4]

The TCJA significantly curtailed one of the major tax incentives for R&D: the immediate deductibility of qualifying R&D spending, including software development spending.[5] In particular, starting in 2022, the TCJA requires that qualifying R&D conducted in the United States be amortized over 5 years, and other qualifying R&D be amortized over 15 years. The Joint Committee on Taxation (JCT) estimates that this tax increase amounts to nearly $119.2 billion over the 2018-27 10-year budget window.[6] This report examines how the TCJA change will affect private R&D investment spending and R&D-related wages and employment in the United States.

It is important to recognize that this policy change is occurring in the context of increased global competition for R&D spending. The United States was one of the first nations to enact a tax incentive for R&D, but other nations have since followed suit. As seen in Figure 1, the OECD reports that, as of 2018, the United States is ranked 26th out of the 36 OECD nations in the value of the tax incentive provided for R&D.[7] Moreover, the value of the US tax incentive for R&D will decline further when the amortization of qualifying R&D expenditures goes into effect in 2022 and the United States will be the only developed country requiring the amortization of R&D expenditures.

Figure 1. Ranking of R&D tax incentives among OECD countries, 2018



Note: This is the US ranking for the implied tax subsidy rate on R&D expenditures for large profitable companies. The implied tax subsidy rate is defined as one minus the B-index. The B-index is the before-tax return needed for a company to break even on a marginal investment. See OECD, R&D Tax Incentive Database, November 2018.
Source: OECD, R&D Tax Incentive Database, November 2018.

II. Modeling approach

This report estimates, in two steps, how amortization of qualifying R&D expenditures will impact private R&D spending and R&D-related employment in the United States. First, this report estimates the effect of the TCJA amortization provision on the cost of capital. This is how economic research has generally estimated the effect of R&D tax incentives on R&D spending. The increase in the cost of capital provides a measure of how much more expensive R&D spending will become due to the TCJA amortization provision. Second, the report estimates how the TCJA amortization provision will affect R&D spending by analyzing the relationship between the tax treatment of R&D spending and the increase in the cost of capital, based on available economic research.

Tax treatment of qualifying R&D spending

The United States has, over many decades, developed a set of tax incentives that are designed to increase R&D investments made by the private sector. These tax incentives have included allowing the immediate deduction of qualifying R&D expenditures and the R&D tax credit (under section 174 and 41 of the Internal Revenue Code (Code), respectively). The immediate deductibility of qualifying R&D expenditures allows companies to deduct the full value of their costs (in present value) rather than having to capitalize the costs and receive deductions over the life of the investment. The R&D tax credit allows taxpayers to take a credit of up to 20% of their increased expenditures on qualifying R&D over a computed base spending under section 41(c) of the Code.

Since 1954, businesses have been allowed to immediately deduct qualifying R&D expenditures; however, starting in 2022, the TCJA requires that qualifying R&D conducted in United States be amortized (spread over) over 5 years and other qualifying R&D be amortized over 15 years. While amortizing the R&D spending amount does not reduce the total amount of the deduction, it requires that taxpayers take the deduction over a longer period of time relative to immediate deductibility, thus reducing the value of the deduction because of the time value of money. From a policy perspective, the capitalization and amortization of R&D expenditures is difficult to justify given that oftentimes the R&D expenditure relates to unsuccessful research that does not create an asset with an extended useful life.

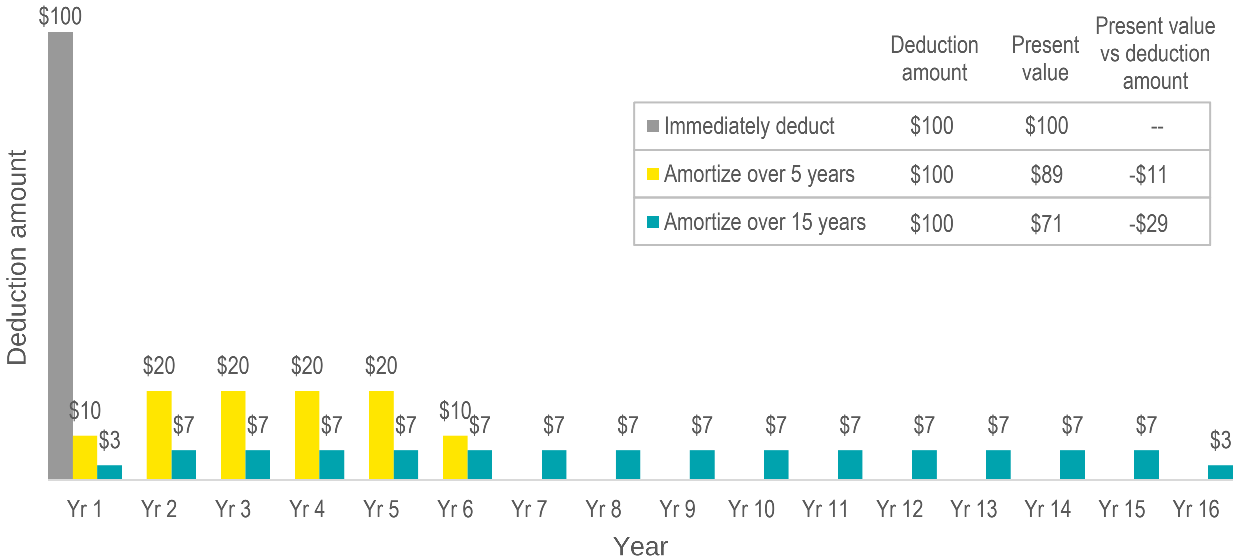
A cash flow's discounted present value shows its value in the first year of the stream of flows, accounting for the time value of money. For example, a dollar received in 10 years is worth less than a dollar today. A dollar received today could be invested to earn a return over the next 10 years, so it would be worth more than one dollar 10 years hence. This is the time value of money. The discounted present value takes this return into account and expresses all future cash flows in an amount that is equivalent to cash received today.

Figure 2 displays a comparison of $100 of qualifying R&D spending that is immediately deductible, amortized over 5 years, and amortized over 15 years. Each of these allows the taxpayer $100 of deductions, but they differ in terms of timing. The immediately deductible R&D spending allows the taxpayer $100 of deduction in the first year. When amortized over 5 years, the deduction amount is spread equally over 5 years ($20/year). However, as seen in Figure 2, the TCJA amortization provision requires that amortization begin with the midpoint of the tax year in which qualifying R&D expenditures are paid or incurred, which reduces the deduction amount in the first year by half ($10) that is then taken in year 6. When amortized over 15 years, the deduction amount is spread equally over 15 years (approximately $7/year). Again, due to the requirement that amortization begin with the midpoint of the tax year in which qualifying R&D expenditures are paid or incurred, half of the deduction amount in the first year is moved to year 16.

Although each of these allow a taxpayer a deduction of $100, they differ in present value because they differ in timing. In particular, relative to immediate deductibility, amortizing the deduction over 5 years reduces the present value by $11 and amortizing the deduction over 15 years reduces the present value by $29. Meaning that, by spreading out the deduction of $100 over a 5 or 15 year period, the value of that dollar declines and that $100 deduction would be the equivalent of immediately deducting only $89 and $71, respectively. Ultimately, this change in law increases the cost of these R&D investments over time as companies would have to pay more tax than they would if the investments were immediately deductible.

Figure 2. Comparison of deduction for $100 of qualifying R&D spending that is immediately deductible, amortized over 5 years, and amortized over 15 years

Each set of bars sums to $100

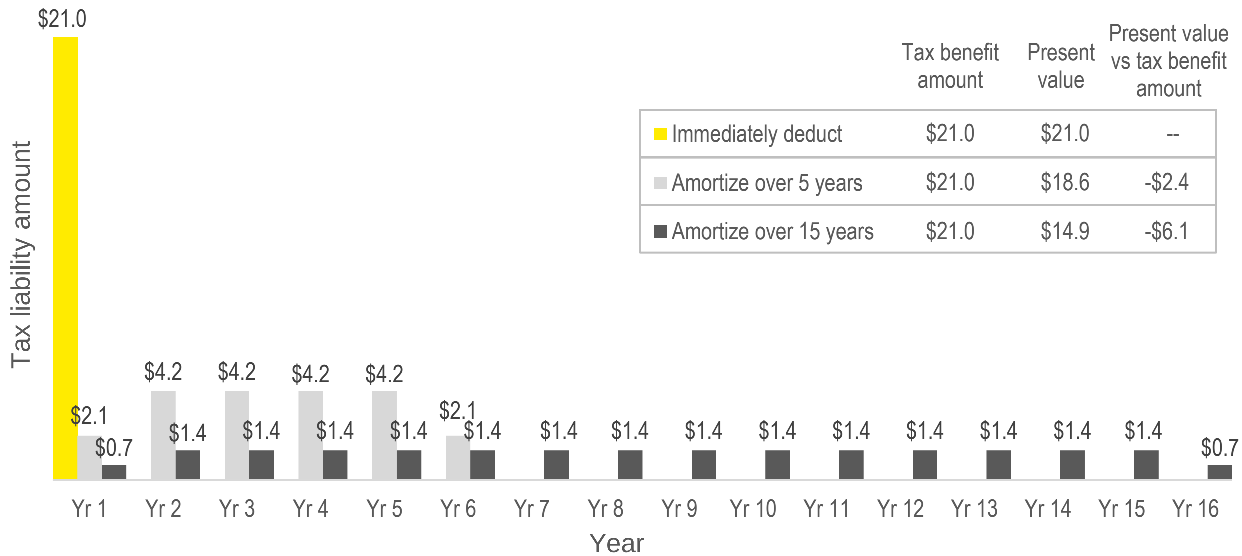


	Deduction amount	Present value	Present value vs deduction amount
Immediately deduct	$100	$100	--
Amortize over 5 years	$100	$89	-$11
Amortize over 15 years	$100	$71	-$29

Note: Figure assumes that amortization begins with the midpoint of the tax year in which qualifying R&D expenditures are paid or incurred, a 5% discount rate, and that a taxpayer is in a taxable position before and after taking the deduction. Figures are rounded.
Source: EY analysis.

Figure 3 expands upon Figure 2 by displaying the tax benefit from $100 of qualifying R&D expenditures that are immediately deductible, amortized over 5 years, and amortized over 15 years. Each of these provide $100 of deduction over the 16-year period shown and, consequently, reduce taxable income by $100. Assuming a 21% corporate income tax rate, this results in a tax benefit of $21 from each. However, taking a deduction sooner reduces taxable income sooner, which, in turn, reduces tax liability sooner. Because of the time value of money, an earlier reduction in tax liability is worth more than the same reduction in tax liability later. In this example, relative to immediate deductibility, the tax benefit is reduced $2.4 (11%) in present value with amortization over 5 years and $6.1 (29%) in present value with amortization over 15 years.

Figure 3. Comparison of tax benefit from deduction for $100 of qualifying R&D spending that is immediately deductible, amortized over 5 years, and amortized over 15 years
Each set of bars sums to $21



Note: Figure assumes a 21% tax rate, that amortization begins with the midpoint of the tax year in which qualifying R&D expenditures are paid or incurred, a 5% discount rate, and that a taxpayer is in a taxable position before and after taking the deduction. Figures are rounded.
Source: EY analysis.

When using the R&D credit, companies may choose one of two R&D credit formulas: (1) the regular credit, or (2) the alternative simplified credit. At a high level, the regular credit is provided at a rate of 20%. This 20% rate is applied to the amount by which a company's qualified research expenses (QRE) in a year exceeds its base amount for that year. The base amount is the company's fixed base percentage multiplied by average gross receipts during the prior four years. The fixed base percentage is the ratio of QRE to gross receipts from 1984 through 1988. A different formula applies to companies that did not have both gross receipts and QRE in at least three of the four years in the 1984-1988 period. The base amount cannot be less than 50% of a company's current QRE. The alternative simplified credit is provided at a rate of 14%. This 14% rate is applied to 50% of QRE that exceeds average QRE during the prior three years.[8]

Companies may not both immediately deduct qualifying R&D spending and take the full credit on that qualifying R&D spending. Specifically, companies may: (1) reduce their deductions for qualifying R&D spending by the amount of the R&D tax credit, or (2) elect to take a smaller R&D credit (i.e., reduce the R&D credit by 21%). Generally, most companies elect to take the reduced credit.[9]

There are also other important considerations around using the R&D credit. For example, if companies do not have sufficient tax liability to use all of their current credits, the incentive effect will be less as the value of the credits would need to be discounted to account for the time value of money over the period for which credit use is delayed. A recent US Treasury Department analysis found that with a 5% discount rate, companies only use 82% of the R&D tax credit in present value.[10] Additionally, the R&D credit cannot be carried forward indefinitely. This analysis assumes that companies can use 82% of their credits but 100% of their allowable deductions.

Cost of capital

In general, companies will make new investments as long as they earn a pre-tax return that exceeds what is required to cover taxes and compensate investors for the use of their capital. A company would not make an investment that earns less because such an investment would be unprofitable. As a result, companies would continue to make (successively less profitable) new investments up to the point at which the last investment earns just enough to cover the taxes due plus enough to compensate investors for the use of their funds. This investment is referred to as the marginal investment. The pre-tax return that it earns is called the cost of capital. The higher the cost of capital, the less a firm will invest.

Taxes are an important component of the cost of capital. Taxes raise a company's cost of capital because the company has to earn enough to cover taxes and still pay a competitive return to its investors. Taxes also can increase the return investors demand on their investments because they have to cover their tax obligations out of the payments they receive from the companies in which they invest. Higher taxes discourage investment by raising the cost of capital.

The Congressional Budget Office (CBO), Congressional Research Service, JCT, and US Treasury Department frequently use the cost of capital framework to quantify the impact of tax changes on investment incentives. The cost of capital framework accounts for the major features of the federal income tax system (e.g., tax depreciation, tax rates, investor-level taxes).

Formally, the cost of capital is the real before-tax rate of return that a barely profitable new investment needs to earn to both cover taxes over its life and provide investors their required after-tax rate of return. The change in taxation on a new, barely profitable investment is a key margin on which to measure the impact of a policy change. For example, an investment that is profitable prior to a policy change and becomes less so, but still profitable, would likely occur with or without the policy change and, consequently, whether or not it occurs is largely unaffected by the policy change. A barely profitable investment, however, could become unprofitable with a policy change and, consequently, whether or not it occurs can be affected by the policy change. Therefore, examining the impact of the amortization of qualifying R&D expenditures on a new, barely profitable R&D investment is a key margin for how much R&D investment occurs in the US economy.

As noted previously, the immediate deductibility of qualifying R&D expenditures allows companies to deduct the full amount of R&D costs immediately rather than having to capitalize the costs and receive deductions over 5 or 15 years. Taking a deduction sooner reduces taxable income sooner, which, in turn, reduces tax liability sooner. Because of the time value of money, an earlier reduction in tax liability is worth more than the same reduction in tax liability later. This is because, for example, a dollar received in 10 years is worth less than a dollar today since a dollar received today could be invested to earn a return over the next 10 years and be worth more than one dollar in 10 years. Consequently, the amortization of qualifying R&D expenditures reduces the tax benefit of deducting R&D costs and, as a result, increases the real before-tax rate of return that a barely profitable new investment needs to earn to both cover taxes over its life and provide investors their required after-tax rate of return (i.e., the cost of capital).

Responsiveness of R&D spending to its tax treatment

Numerous studies have examined the linkage between R&D tax incentives and R&D spending. Most often these studies link changes in the after-tax cost or "price" of R&D to R&D spending, controlling for a variety of other factors that may also influence R&D spending. Many studies use company-level data, which provides a rich source from which to capture the impact of differences in the tax treatment of R&D over time and across companies on R&D spending.[11] Other studies use aggregated industry data, country data, and state-level data.[12]

The different approaches allow for different sets of controls to account for non-tax factors that may influence R&D spending. Importantly, the studies also draw on different incentive structures over time, across different companies, across countries, and across states. Despite considerably varied results, most studies find tax incentives have sizable effects on R&D spending, and long-run effects tend to be considerably larger than short-run effects.

Studies typically measure the responsiveness of R&D to its tax cost or the cost of capital using a measure called elasticity. Elasticity measures the percentage change in R&D spending caused by a one percent change in tax cost or cost of capital. This report assumes a short-run elasticity of -0.4 and a long-run elasticity of -1.0. That is, for every 1% increase in the cost of capital, qualifying R&D spending would be 0.4% lower in the short run and 1% lower in the long run.[13] This report defines the short run as the first five years and the long run as the second five years and beyond.

The TCJA requirement to amortize expenses over a period of years will not only impact R&D spending in the United States, but could also impact where companies choose to locate their intellectual property. As outlined earlier, economic research generally finds that R&D is responsive to its tax treatment. Companies perform R&D on a global basis. This is often done to enhance and complement US operations, by diversifying research and using talent across the company's operations. Companies that own their intellectual property in the United States would be particularly impacted by the fact that other qualifying R&D expenses must be amortized over 15 years, which could, in turn, impact companies' decisions to locate their intellectual property outside the United States.

III. Impact of the amortization of qualifying R&D expenditures on R&D spending and R&D-related jobs and labor income

Table 1 displays the estimated change in qualifying US R&D spending relative to the 2018 US economy. The change is decomposed into four components: (1) wages for qualified services, (2) cost of supplies, (3) rental or lease costs of computers, and (4) qualifying contract research expense.

Wages for qualified services is compensation treated as wages for income tax withholding purposes paid to in-house employees for their work directly performing, supervising, or supporting qualified research. Supplies include tangible property used or consumed in R&D other than land, improvement to land, and depreciable property. This could include, for example, general office supplies, components for prototypes, and chemicals consumed in the R&D. Utilities generally do not qualify, but can in cases where extraordinary utility use is required for the R&D. The rental or lease of computers is the amount paid to use computers for qualified research. Qualifying contract research expenses generally includes 65% of the amount paid to third-party contractors for qualifying research activities. For this research to qualify the taxpayer must retain some rights to the R&D and bear the risk of it being unsuccessful. Overall, total qualifying R&D expenditures are approximately 69% wages for qualified services, 16% cost of supplies, less than 0.5% rental or lease costs of computers, and 15% qualifying contract research expense.

Over the first five years, the amortization of qualifying R&D expenditures is estimated to reduce US R&D spending by approximately $4.1 billion annually. The majority of this reduction in R&D spending is in reduced wages for qualified services ($2.8 billion). The remainder of this reduction in R&D spending is from reduced spending on supplies ($0.6 billion), qualifying contract research expense ($0.6 billion), and the rental or lease of computers (less than $0.05 billion).

Table 1. Annual decline in qualifying US R&D spending relative to the 2018 US economy, by type
Billions of dollars

		Change in US R&D spending	
	Projected qualifying R&D spending, 2018	First five years: Amortize qualifying R&D	Second five years and beyond: Amortize qualifying R&D
Qualifying US R&D spending	**$275.7**	**$4.1**	**$10.1**
Wages for qualified services	$189.3	$2.8	$7.0
Cost of supplies	$43.8	$0.6	$1.6
Rental or lease costs of computers	$0.3	*	*
Qualifying contract research expense	$42.4	$0.6	$1.6

*Less than $0.05 billion.
Note: This report projects qualifying R&D spending using the most recent Internal Revenue Service data (2013) and the growth rate of business R&D spending through 2018 reported by the US Bureau of Economic Analysis. The share of qualifying R&D spending by type is assumed to be the same in 2018 as the most recent Internal Revenue Service data. Figures are rounded.
Source: EY analysis.

Over the second five years and beyond, the amortization of qualifying R&D expenditures is estimated to reduce US R&D spending by $10.1 billion annually. This $10.1 billion is comprised of a reduction in R&D spending on wages for qualified services ($7.0 billion), supplies ($1.6 billion), qualifying contract research expenses ($1.6 billion), and the rental or lease of computers (less than $0.05 billion).

Impact of reduced R&D spending on R&D-related jobs and labor income

Because most R&D spending is payments to employees performing, supervising, or supporting qualified research, there are significant linkages between R&D spending and the labor market. In particular, the estimated reduction in US R&D spending from the amortization of qualifying R&D expenditures would result in a reduction in R&D-related jobs and labor income.

As seen in Table 1, over the first five years, the reduction in payments to wages for qualified services is estimated to be $2.8 billion annually, rising to $7.0 billion annually in the second five years and beyond. Additional reductions in R&D employment payments also make up part of the reduction in qualifying contract research expense. As seen in Table 2, this report estimates that, in total, the reduction in R&D spending will reduce payments toward US R&D employment by $3.3 billion annually in the first five years and $8.2 billion annually in the second five years and beyond. This translates to a loss of 23,400 US R&D jobs in each of the first five years and 58,600 in each of the second five years and beyond. The change in R&D employment is not additive across years. For example, in each of the first five years it is the same 23,400 R&D jobs earning $3.3 billion each year.

Table 2. Annual decline in US R&D-related employment and labor income relative to 2018 US economy

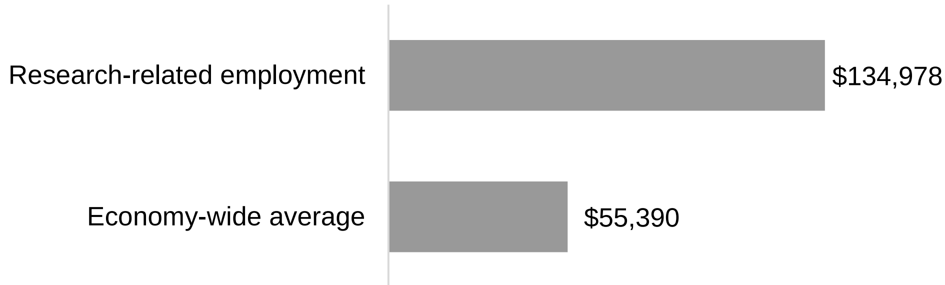
Number of jobs; billions of dollars

	First five years: Amortize qualifying R&D	Second five years and beyond: Amortize qualifying R&D
R&D employment	23,400	58,600
R&D labor income	$3.3	$8.2

Note: The change in R&D employment is not additive across years. For example, in each of the first five years it is the same 23,400 R&D jobs earning $3.3 billion each year. The change in R&D employment is estimated by dividing the estimated change in R&D wages by the average wage per R&D job. US Bureau of Labor Statistics data for NAICS 54171 Research and Development in the Physical, Engineering, and Life Sciences are used to estimate the average wage per R&D-related job: $137,978 in 2017 projected to $140,212 in 2018. The change in R&D-related wages is the sum of the change in wages for qualified services and 81% of qualifying contract research expenses (i.e., the share of qualifying R&D spending that goes toward wages for qualified services excluding qualifying contract research expenses). Figures are rounded.
Source: EY analysis.

Notably, these are high-paying research jobs. As seen in Figure 4, the US Bureau of Labor Statistics reports that in 2017 the average annual wage for R&D-related employment was $134,978. This is more than 2.4 times higher than the economy-wide annual average wage.

Figure 4. Average annual R&D-related wage compared to economy-wide annual average wage, 2017



Note: US Bureau of Labor Statistics data for NAICS 54171 Research and Development in the Physical, Engineering, and Life Sciences are used to estimate the average wage per R&D-related job.
Source: US Bureau of Labor Statistics.

IV. Impact of the amortization of qualifying R&D expenditures on R&D-related suppliers and consumer spending

The reduction in US R&D spending and associated R&D employment and labor income would have effects on the broader US economy. In particular, the reduction in spending on R&D supplies and the rental or leasing of computers would reduce payments to the suppliers of companies conducting R&D. This, in turn, would reduce employment and labor income at these suppliers. Additionally, the reduction in labor income paid to the R&D and supplier employees would reduce the consumer spending of these employees. As a result, this would reduce the employment and labor income at businesses supported by R&D-related consumer spending (e.g., grocery stores and restaurants).

This report uses a partial equilibrium approach to estimate the amount of economic activity supported by the R&D spending that would occur if not for the amortization of qualifying R&D expenditures.[14] The IMPLAN input-output model of the United States, which describes the economic linkages of more than 500 industries, is used for this analysis. The economic activity supported by this R&D spending is divided into three parts: (1) direct (R&D employment and labor income), (2) indirect (supplier-related employment and income), and (3) induced (consumption-related employment and income).

Table 3 displays the direct, indirect, and induced economic activity supported by the US R&D spending that would occur if not for the amortization of qualifying R&D expenditures. As noted previously, over the first five years this US R&D spending annually supports 23,400 R&D jobs earning $3.3 billion. In addition, the US R&D spending on supplies and the rental or leasing of computers is estimated to annually support 4,700 additional jobs earnings $0.4 billion. Moreover, because the R&D jobs are high-paying, the associated consumer spending supports a significant number of jobs. In particular, this consumer spending is estimated to annually support 39,600 jobs earning $2.1 billion. In total, over the first five years, the $4.1 billion of annual US R&D spending that would occur if not for the amortization of qualifying R&D expenditures is estimated to support 67,700 jobs earning $5.8 billion annually in the United States. The employment supported is not additive across years. For example, in each of the first five years it is the same 67,700 R&D jobs earning $5.8 billion each year.

Over the second five years and beyond the economic activity supported by the US R&D spending that would occur if not for the amortization of qualifying R&D expenditures more than doubles. As noted previously, this US R&D spending annually supports 58,600 R&D jobs earning $8.2 billion. In addition, the US R&D spending on supplies and the rental or leasing of computers is estimated to annually support 11,700 additional jobs earnings $0.9 billion. Moreover, the related consumer spending is estimated to annually support 99,100 jobs earning $5.3 billion. In total, the $10.1 billion of annual US R&D spending that would occur if not for the amortization of qualifying R&D expenditures is estimated to support 169,400 jobs earning $14.4 billion annually in the United States.[15]

Overall, for every $1 billion of US R&D spending 17,000 jobs earning $1.4 billion are supported in the United States. A summary of the economic activity supported by the R&D that would occur if not for the amortization of qualifying R&D expenditures is displayed in Figure 5.

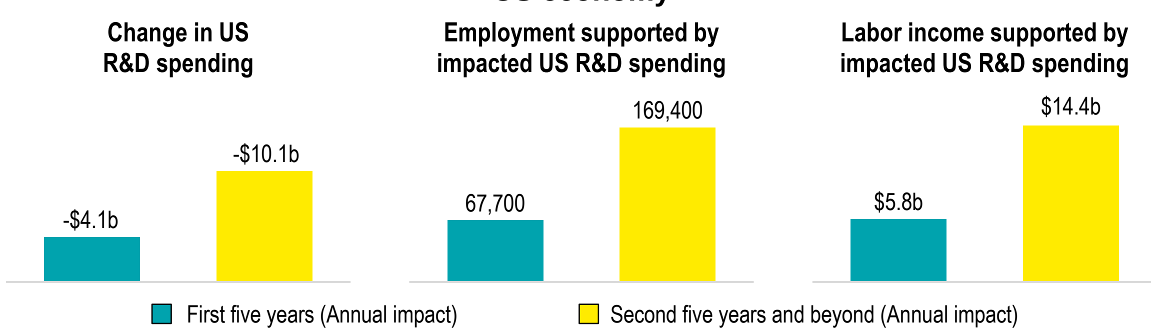
Table 3. Annual amount of economic activity supported by the R&D spending that would occur if not for the amortization of qualifying R&D expenditures relative to 2018 US economy

Number of jobs; billions of dollars

	First five years		Second five years and beyond	
	Employment	Labor income	Employment	Labor income
Direct	23,400	$3.3	58,600	$8.2
Indirect	4,700	$0.4	11,700	$0.9
Induced	39,600	$2.1	99,100	$5.3
Total	**67,700**	**$5.8**	**169,400**	**$14.4**

Note: The employment supported is not additive across years. For example, in each of the first five years it is the same 67,700 R&D jobs earning $5.8 billion each year. Figures are rounded.
Source: EY analysis.

Figure 5. Summary of amount of economic activity supported by the R&D spending that would occur if not for the amortization of qualifying R&D expenditures relative to 2018 US economy



Note: The change in R&D employment is not additive across years. For example, in each of the first five years it is the same 23,400 R&D jobs earning $3.3 billion each year. All impacts are scaled to the size of the US economy in 2018.
Source: EY analysis.

V. Caveats and limitations

Any modeling effort is only an approximate depiction of the economic forces it seeks to represent, and the economic model developed for this analysis is no exception. Although various limitations and caveats might be listed, several are particularly noteworthy:

- **Estimates are limited by available public information.** The analysis relies on information reported by federal government agencies (primarily from the US Bureau of Economic Analysis, the US Bureau of Labor Statistics, and Internal Revenue Service). The analysis did not attempt to verify or validate this information using sources other than those described in the report.

- **The responsiveness of R&D spending to its after-tax cost is uncertain.** A review of the economic literature suggests that a central estimate of the responsiveness of R&D spending to its cost of capital is -0.4 in the short run and -1.0 in the long run. The actual elasticity of R&D spending with respect to the cost of capital may differ from this assumption.

- **Timing of short run and long run is uncertain.** The economic literature estimates the responsiveness of R&D spending to its after-tax cost in the short run and long run, but the precise duration of short run and long run is uncertain. This report defines short run as the first five years and the long run as the second five years and beyond to provide a specific time interval for these estimates. Somewhat different time intervals could also be appropriate.

- **The annual average R&D-related wage is assumed to be unaffected by the policy change.** To estimate the change in R&D-related employment, the change in R&D-related wages is divided by the annual average R&D-related wage. However, the reduced demand for R&D-related employment resulting from the amortization of qualifying R&D spending may result in a reduction of the annual average R&D-related wage.

- **The composition of qualifying R&D spending is assumed to be unaffected by the policy change.** Baseline qualifying R&D uses the most recent Internal Revenue Service data (2013) projected to 2018 with the US Bureau of Economic Analysis' data on the growth rate of business R&D spending. The share of qualifying R&D spending by type is assumed to be the same in 2018 as the most recent Internal Revenue Service data. However, the composition of qualifying R&D spending may change over time and as a result of the amortization of qualifying R&D spending.

- **The analysis estimates the impact of the amortization of R&D relative to the 21% corporate income tax rate.** The analysis assumes the 21% corporate income tax rate that the amortization provision helped to finance remains in place. If the rate were to increase, the estimated impacts would likely be somewhat larger.

Appendix A. Cost of capital framework

The cost of capital for an investment is estimated using the framework first formalized by Hall and Jorgenson (1967), and later refined by Fullerton and King (1984), and described in detail by Gravelle (1994) and Mackie (2002). The cost of capital (net of depreciation) is given by:

$$c = \frac{(r + \delta - \pi)(1 - uz)}{1 - u} - \delta$$

where c denotes the cost of capital, r is the firm's nominal after-tax discount rate, δ is the rate at which the asset depreciates, π is the rate of inflation, u is the corporate income tax rates, and z is the present value of depreciation allowances. The present value of depreciation, z, reflects the discount rate, the tax life of an asset, the depreciation schedules, and other elements of the depreciation system. The values of δ and z vary by type of asset as depreciation allowances for equipment are typically accelerated compared to their economic lives.

Investor-level taxes and the deductibility of interest are accounted for by assuming that a firm can arbitrage between debt and real capital following Fullerton and Bradford (1981) and Fullerton, Gillette, and Mackie (1987). Investments are frequently financed with both debt and equity financing. Thus, this study calculates the cost of capital for a hypothetical new investment based on a weighted average of debt and equity financing.[16]

A further issue involves a firm's marginal source of equity financing. That is, whether the old or new view of dividend taxes applies. This report follows Auerbach and Hassett (2003) and assumes that one-half of equity finance operates under the "old" view, whereby dividend taxes affect investment decisions, and the other half of firms operate under the "new" view, whereby firms rely on retained earnings as the marginal source of finance, and dividend taxes are capitalized into firm value.[17]

The cost of capital for equity-financed investment includes the investor-level taxes on capital gains and dividends (i.e., the double tax on corporate profits), whereas the cost of capital for debt-financed investment reflects the deductibility of interest at the corporate level and the assumption that about one-half of debt holders are either tax-exempt or lightly taxed (e.g., pension assets/foreigners).

Appendix B. Impacts by state

Table B-1. Annual decline over the first five years in R&D spending, R&D-related wages, and R&D-related employment, by state

Number of jobs; millions of dollars

	R&D spending	Wages	Employment
United States	**$4,053**	**$3,287**	**23,443**
Alabama	11	9	65
Alaska	*	*	2
Arizona	62	50	356
Arkansas	4	4	26
California	1,374	1,114	7,946
Colorado	46	37	266
Connecticut	79	64	458
Delaware	19	15	110
District of Columbia	3	2	17
Florida	58	47	334
Georgia	55	45	321
Hawaii	1	1	9
Idaho	18	15	105
Illinois	154	125	888
Indiana	65	53	375
Iowa	29	23	167
Kansas	19	15	110
Kentucky	10	8	56
Louisiana	3	2	17
Maine	3	3	20
Maryland	43	35	251
Massachusetts	235	190	1,359
Michigan	227	184	1,311
Minnesota	86	70	496
Mississippi	3	2	15
Missouri	45	37	260
Montana	2	1	9
Nebraska	6	5	37
Nevada	5	4	31
New Hampshire	10	8	58
New Jersey	168	136	969
New Mexico	4	3	24
New York	175	142	1,011
North Carolina	94	76	543
North Dakota	3	2	18
Ohio	83	67	478
Oklahoma	8	7	48
Oregon	82	67	474
Pennsylvania	145	118	838
Rhode Island	11	9	62
South Carolina	15	12	86
South Dakota	2	1	10
Tennessee	18	15	104
Texas	194	157	1,120
Utah	37	30	216
Vermont	3	2	17
Virginia	29	24	168
Washington	247	200	1,427
West Virginia	2	2	12
Wisconsin	57	46	330
Wyoming	2	2	12

*Less than $0.05 million.

Note: Estimates are distributed to the states (plus the District of Columbia) based on the National Science Foundation's 2016 funds spent for business R&D performed in the United States paid for by the company. These data were the most recent National Science Foundation data at the time of the analysis. Figures may not sum due to rounding.

Source: EY analysis.

Table B-2. Annual decline over the second five years and beyond in R&D spending, R&D-related wages, and R&D-related employment, by state
Number of jobs; millions of dollars

	R&D spending	Wages	Employment
United States	**$10,131**	**$8,217**	**58,608**
Alabama	28	23	163
Alaska	1	1	5
Arizona	154	125	891
Arkansas	11	9	64
California	3,434	2,785	19,864
Colorado	115	93	665
Connecticut	198	161	1,146
Delaware	47	39	275
District of Columbia	7	6	43
Florida	144	117	834
Georgia	139	113	802
Hawaii	4	3	21
Idaho	45	37	263
Illinois	384	311	2,220
Indiana	162	131	937
Iowa	72	59	418
Kansas	48	39	276
Kentucky	24	20	141
Louisiana	7	6	43
Maine	8	7	49
Maryland	108	88	626
Massachusetts	587	476	3,396
Michigan	567	460	3,278
Minnesota	214	174	1,240
Mississippi	6	5	37
Missouri	113	91	651
Montana	4	3	23
Nebraska	16	13	92
Nevada	13	11	77
New Hampshire	25	20	144
New Jersey	419	340	2,423
New Mexico	10	9	61
New York	437	354	2,527
North Carolina	235	190	1,357
North Dakota	8	6	45
Ohio	207	168	1,196
Oklahoma	21	17	121
Oregon	205	166	1,186
Pennsylvania	362	294	2,096
Rhode Island	27	22	154
South Carolina	37	30	215
South Dakota	4	4	25
Tennessee	45	36	260
Texas	484	393	2,801
Utah	93	76	540
Vermont	7	6	43
Virginia	73	59	421
Washington	617	500	3,569
West Virginia	5	4	29
Wisconsin	142	116	824
Wyoming	5	4	31

*Less than $0.05 million.
Note: Estimates are distributed to the states (plus the District of Columbia) based on the National Science Foundation's 2016 funds spent for business R&D performed in the United States paid for by the company. These data were the most recent National Science Foundation data at the time of the analysis. Figures may not sum due to rounding.
Source: EY analysis.

Appendix C. Ranking of states by ratio of R&D spending to gross state product

Table C-1. Ranking of states by ratio of R&D spending to gross state product, 2016

1	California	27	Maryland
2	Washington	28	Georgia
3	Michigan	29	Vermont
4	Massachusetts	30	South Carolina
5	Oregon	31	Florida
6	Connecticut	32	North Dakota
7	New Jersey	33	Wyoming
8	Delaware	34	Virginia
9	Idaho	35	Maine
10	Minnesota	36	Alabama
11	Utah	37	Nebraska
12	Pennsylvania	38	Tennessee
13	Arizona	39	Kentucky
14	Indiana	40	Oklahoma
15	Illinois	41	New Mexico
16	Rhode Island	42	Arkansas
17	Wisconsin	43	South Dakota
18	North Carolina	44	Nevada
19	Iowa	45	Montana
20	Missouri	46	West Virginia
21	Colorado	47	Mississippi
22	Ohio	48	District of Columbia
23	New Hampshire	49	Hawaii
24	Texas	50	Louisiana
25	Kansas	51	Alaska
26	New York		

Note: Ranking is based on 2016 data. This is the most recent year for which data was available from the National Science Foundation. R&D only includes R&D paid for by companies.
Source: National Science Foundation; US Bureau of Economic Analysis; EY analysis.

Endnotes

[1] Joint Committee on Taxation, *Estimated Budget Effects of the Conference Agreement for H.R.1, the "Tax Cuts and Jobs Act,"* JCX-67-17, December 18, 2018.
[2] See, for example, Congressional Research Service, *Research Tax Credit: Current Law and Policy Issues for the 114th Congress*, March 13, 2015 and Joint Committee on Taxation, *Economic growth and tax policy*, May 16, 2017 (JCX-19-17).
[3] R&D spending that qualifies for expensing under IRC Section 174 and for the R&D tax credit have similar though different definitions. For the purpose of this report, R&D spending generally refers to R&D that would qualify for the R&D tax credit. Additionally, the Internal Revenue Code refers to "research and experimentation" or "R&E" rather than the more commonly used "research and development" or "R&D." This report treats the terms "R&D" and "R&E" as interchangeable.
[4] See, for example, Robert Carroll, Gerald Prante, and Robin Quek, *The R&D Credit: An effective policy for promoting research spending*, An EY report prepared for the R&D Credit Coalition, September 2011.
[5] Here and throughout the report "qualifying" or "certain" R&D expenditures refers to section 174 R&D expenditures. Section 174 is discussed in more detail in the "Tax treatment of qualifying R&D spending" section of the report.
[6] *Supra*, note 1.
[7] This is the US ranking for the implied tax subsidy rate on R&D expenditures for large profitable companies. The implied tax subsidy rate is defined as one minus the B-index. The B-index is the before-tax return needed for a company to break even on a marginal investment. See OECD, *R&D Tax Incentive Database*, November 2018. The OECD includes Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.
[8] This analysis uses a weighted average of the two credit methods based on respective usage reflected in recent tax return data from the Internal Revenue Service, Statistics of Income Division.
[9] See US Department of the Treasury, Office of Tax Analysis, Research And Experimentation (R&E) Credit, October 12, 2016.
[10] Ibid.
[11] See Bronwyn Hall, (1992), "Investment and R&D at the firm level: Does the source of financing matter? National Bureau of Economic Research, NBER Working Paper 4096; James Hines, (1993), "On the Sensitivity of R&D to Delicate Tax Changes: The Behavior of U.S. Multinationals in the 1980s," *Studies in International Taxation,* Alberto Giovannini, R. Glenn Hubbard, and Joel Slemrod, eds., (Chicago: University of Chicago Press); Sanjay Gupta, Yuhchang Hwang, and Andrew Schmidt, (2006), "An Analysis of the Availability and Incentive Effects of the R&D Tax Credit After the Omnibus Budget Reconciliation Act of 1989," mimeograph, Arizona State University, W.P. Carey School of Business; and Nirupama Rao, (2013), "Do Tax Credits Stimulate R&D Spending? The Effect of the R&D Tax Credit in its First Decade," New York University, The Wagner School.
[12] See Nick Bloom, Rachel Griffith, and John Van Reenen, (2002), "Do R&D Tax Credits Work? Evidence from a Panel of Countries, 1979-1997," *Journal of Public Economics* 85: 1-31; Theofanis Mamuneas and M. Ishaq Nadiri, (1996), "Public R&D Policies and Cost Behavior of the U.S. Manufacturing Industries," *Journal of Public Economics* 63(1): 57-81; Daniel Wilson, (2011), "Beggar Thy Neighbor? The In-State, Out-of-State, and Aggregate Effects of R&D Tax Credits," *Review of Economics and Statistics* 91: 431-436.
[13] There is a large volume of economic research estimating the responsiveness of R&D spending to its after-tax cost. Hall and Van Reenen (2000) surveys the literature through the late 1990s and concludes that the central estimate of the literature is an elasticity of -1.0. That is, a 1% increase in the after-tax cost of R&D spending would result in a 1% decrease in R&D spending. While this remains the central estimate of the more recent literature, some recent studies suggest the elasticity may be as high as -2.0. Recent estimates similar to the central estimate include, for example, Bloom, Griffith, and Van Reenen (2002) (-1.1), Bloom, Schankerman, and Van Reenen (2013) (-0.7), and Guceri (2018) (-0.9 to -1.2). Larger estimates can be found in Guceri and Liu (2017) (-1.6) and Rao (2016) (-2.0). The literature has also found

that this long-run elasticity is generally much larger than in the short-run elasticity. One potentially significant issue in estimating the responsiveness of R&D spending to its after-tax cost is relabeling. Relabeling refers to companies characterizing non-R&D spending as R&D spending so as to benefit from preferential tax treatment. The evidence on the importance of relabeling is mixed. Rao (2016), in addition to estimating an elasticity with confidential corporate tax return data, also matches these tax returns to company financial statement data that include both qualified and non-qualified R&D spending (i.e., total R&D spending). This additional analysis in Rao (2016) provides evidence that companies increase their share of R&D spending that is qualified rather than increase total R&D spending, but the analysis is only for a small set of companies (i.e., at most 76 companies). In contrast to this result, Guceri (2018) finds that preferential tax treatment for R&D spending increases R&D spending, but does not result in reduced non-R&D investment or non-R&D expenses. See Bronwyn Hall and John Van Reenen, (2000), "How Effective are Fiscal Incentives for R&D? A Review of the Evidence," *Research Policy* 29: 449-469; Nick Bloom, Rachel Griffith, and John Van Reenen, (2002), "Do R&D Tax Credits Work? Evidence from a Panel of Countries 1979-1997," *Journal of Public Economics* 85(1): 1-31; Nicholas Bloom, Mark Schankerman, and John Van Reenen, (2013), "Identifying Technology Spillovers and Product Market Rivalry," *Econometrica* 81(4): 1347-1393; Nirupama Rao, (2016), "Do Tax Credits Stimulate R&D Spending? The Effect of the R&D Tax Credit in its First Decade," *Journal of Public Economics* 140:1-12; Irem Guceri and Li Liu, (2017), "Effectiveness of Fiscal Incentives for R&D: Quasi-Experimental Evidence," IMF Working Paper 17/84; and Irem Guceri, (2018), "Will the real R&D employees please stand up? Effects of tax breaks on firm-level outcomes," *International Tax and Public Fina*nce 25(1): 1-63.

[14] When an input-output model is used to estimate the impact of a change in policy the analysis assumes that the change is small enough that price levels, wage rates, and the output of various industries stay the same. For instance, an input-output model would predict that a reduction in a given industry's output would reduce that industry's employees, employee income, and operating expenses in an amount proportional to the reduction in output. However, a general equilibrium approach would refine this estimate to reflect that wage levels may decrease as a result of the reduction in an industry's employment, which would in turn cause other industries to hire more employees, partially offsetting the initial shock to employment. This general equilibrium approach more accurately reflects the actual economic relationships that exist in a market economy.

[15] The OECD reports that, in 2018, the average wage tax rate for individuals at 150% of the average wage in the United States was approximately 20.2%. This is a combined federal (13.8%) and state (6.4%) average wage tax rate. The average wage in the United States in 2018, as reported by the OECD, was approximately $55,000 and the average wage for jobs supported by R&D spending (direct, indirect, and induced) is approximately $85,000 relative to the 2018 US economy. This suggests that the economic activity supported by the R&D spending that would occur if not for the amortization of qualifying R&D expenditures supports, on average, $1.2 billion of wage taxes annually in the first five years and $2.9 billion of wage taxes annually in the second five years and beyond relative to 2018 US economy. The OECD estimates are for a single individual with no dependents. See OECD, *Taxing Wages 2019*, April 11, 2019.

[16] This and many other assumptions are based on James Mackie, (2002), "Unfinished Business of the 1986 Tax Reform Act: An Effective Tax Rate Analysis of Current Issues in the Taxation of Capital Income," *National Tax Journal* 45(2): 293-337.

[17] More recent empirical research suggests that the new view may be more prevalent among firms; see Kevin Hassett and Kathryn Newmark, (2008), "Taxation and Business Behavior: A Review of the Recent Literature," *Fundamental Tax Reform: Issues, Choices and Implications,* MA: MIT Press.