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THE EFFECTS OF THE TAX REFORM ON ENERGY AND ENVIRONMENTAL RESEARCH AND DEVELOPMENT

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EXECUTIVE SUMMARY

Changes in the 2017 tax reform to the tax treatment of research and development (R&D) may be an explanation for an observed increase in private sector R&D investment in energy and environmental R&D (E&E R&D). Prior to the tax reform, private sector E&E R&D was relatively stagnant, only increasing by 2 percent from 2012-2017. After the tax reform, E&E R&D jumped by $3.3 billion, or 11.8 percent. Private sector E&E R&D is roughly seven times as large as public sector R&D and fulfills a fundamentally different role in the innovation life cycle than public sector R&D, so the increase in private sector innovation may mark a win for investment in technologies that are key in the pursuit of global climate objectives.

Conversely, the jump in R&D could be temporary in nature. Since the most impactful changes to the tax code for R&D were temporary, it is possible that companies may simply be trying to move as much of their projected R&D to an earlier timeframe to capture a preferential tax treatment. Until further data is available, it will be difficult to pin down exactly what conditions of 2018 best explain the increase in both E&E R&D and economy-wide R&D.

Overall, the early data post-tax reform is promising, indicating that at least some of the policies included reforms achieved the hoped-for objectives of stimulating private sector investments in potential avenues for productivity. Importantly, though, this analysis is focused on R&D—specifically E&E R&D—and not the overall tax reform, which undoubtedly given its size has variability in which policies may have been effectual or not.

As policymakers move forward, they should keep in mind the significant impact that tax policy has on the incentives for the private sector to invest in innovation in the United States, including sectors that may be key for broader political priorities like climate change. They should also exercise discipline when seeking to raise taxes on capital, as they may inadvertently diminish investment opportunities in sectors that policymakers are otherwise seeking to amplify.

Key Findings

- Immediately following the tax reform, economy-wide private sector R&D paid for and performed by companies increased by $38.8 billion, or 11.4 percent—nearly double the 6.4 percent increase of the year prior.
- Private sector E&E R&D increased after the tax reform by $3.3 billion, or 11.8 percent, its largest increase in the observed data, and significantly higher than its 2012-2017 increase of only 2 percent.
- The share of private sector E&E R&D relative to total economy-wide R&D following the tax reform also slightly increased, a change from its expected decline, indicating that there may be more appetite for E&E R&D investment in the private sector than previously expected.

Key Recommendations

- Make permanent the tax reform's authorization of R&D expensing in lieu of R&D amortization, which would preserve the incentive for the private sector to invest in innovation.
- Avoid the temptation to implement or restore taxes on capital to pay for public spending, as the harm to future productivity from the tax may outweigh the benefit of public spending.

- Understand that transferring too much of the costs of mature energy and environmental technology to the public sector may crowd out private sector investment, as competing technologies would have to compete with subsidized technology to enter into market.

- Do not neglect the comparative advantages of both private- and public-sector innovation; the private sector is better at scaling and commercializing near-mature technology with profitable applications, and the public sector is better at advancing not-yet-profitable technologies that may yield long-term societal benefits.

INTRODUCTION

In December 2017, the Tax Cuts and Jobs Act (more commonly known as the tax reform) was signed into law. Although significant media attention focused on the impacts of the tax reform to individuals, the key objectives of the law were to improve the global competitiveness of the U.S. tax code, and to incentivize investment in private sector innovation. Although the tax reform did not specifically target energy or environmental innovation, these sectors were still affected and experienced increases in overall research and development (R&D) investment just as the rest of the economy did. Given that innovation is a commonly sought priority in the pursuit of clean energy technology that can achieve global climate change objectives, the change in investment in these sectors may indicate that there is perhaps more opportunity for private sector-driven innovation related to energy and environmental progress than was previously pursued. The effects of the tax reform on private sector innovation offer insights into the role of tax policy in facilitating clean energy innovation.

THE IMPORTANCE OF PRIVATE SECTOR R&D IN ENERGY AND ENVIRONMENTAL TECHNOLOGY

To date, almost all the focus on public policy and energy innovation has been on the role of public spending on energy innovation, its regulatory treatment or the support (or curtailment) of technology-specific subsidies. What has received far less attention, however, is the role of the general tax treatment of R&D in facilitating energy R&D. The importance of this is due to the public spending phenomenon of "crowding out."

In economics, the term "crowding out" refers to one of two phenomena: the role of increased public debt's impact on the redirection of funds available for lending to the public sector and away from the private sector, or the role of increased public spending in supplanting private sector investment. For this paper, it is the latter example that is of note. For energy R&D, which has been a major focus of public spending to combat climate change, there is a possibility that significant increases to spending may be accompanied by diminished private sector incentives to take up competing opportunities for energy and environmental research and development (E&E R&D). As the public sector fills in investment in opportunities that the private sector otherwise would see as profitable, they may simply opt not to invest in any innovation at all if there are no other investment opportunities they view as worthwhile. Incidentally, too much public investment can result in an overall suboptimal level of economy-wide investment, if public sector R&D strays too far into areas where there is a strong private-sector appetite for investment.

To avoid crowding out, public policy should focus on opportunities to expand private sector E&E R&D. Removing barriers in the tax code and regulatory treatment to innovation can spur greater overall R&D.[1] It should be noted, though, that public R&D and private R&D have separate opportunities for energy innovation. Traditionally, publicly funded R&D is most effective when targeted at early-stage research that may be unprofitable for many years or has a high likelihood of spillover benefits (where competitors are able to benefit from the initial R&D financier's investments).[2] On the other hand, public R&D is an ill-suited means to support later-stage technologies because, compared to the private sector, it has no advantage in lowering production costs (something typically best achieved with the scale and experience of the private sector).[3] Public spending on R&D is most effective when complementary to the private sector, and crowding out from public spending on R&D is most likely to occur when spending is too high, as the Organization for Economic Co-operation and Development (OECD) notes that funding business R&D beyond 25 percent of costs is more likely to crowd out rather than stimulate business R&D.[4]

Conversely, even though private sector R&D is not well-situated to address early-stage innovation, it is essential in the capitalization and deployment of emerging technologies. Because publicly funded institutions do not bear the risk of failure (instead, taxpayers do), they have no incentives to correctly identify best-available technologies, nor do they

1. "Federal Policies and Innovation," Congressional Budget Office, November 2014, p. 38. https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/49487-Innovation.pdf.

2. Philip E. Auerswald et al., "Understanding Private-Sector Decision Making for Early-Stage Technology Development," National Institute of Standards and Technology, September 2005, p. 28. https://www.nist.gov/system/files/documents/2017/05/09/gcr02-841a.pdf.

3. "Federal Support for the Development, Production, and Use of Fuels and Energy Technologies," Congressional Budget Office, November 2015, p. 19. https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/50980-energysupportonecol-3.pdf.

4. Dominique Guellec, Bruno Van Pottelsberghe de la Potterie, "The Impact of Public R&D Expenditure on Business R&D," *OECD Science, Technology and Industry Working Papers* No. 2000/04, June 2000, p. 18. https://www.oecd-ilibrary.org/docserver/670385851815.pdf.

suffer the consequences from failing to do so. Only the private sector can effectively commercialize new technology, and to date policy facilitating its role in doing so has been neglected.[5]

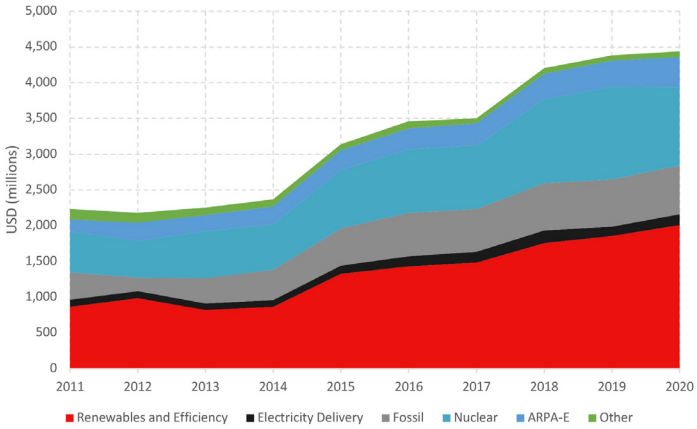
Private-sector driven R&D is especially important when considering the global nature of a collective action problem such as climate change. If decarbonization technologies in the United States and Western Europe are only adopted due to a bevy of subsidies or mandates, they will only be taken up in nations where a high per-capita income allows the population to absorb the "green premium" of clean technology.[6] When technology is subsidized or mandated, it is shielded from competition, and has diminished incentives to reduce costs to expand market share.[7]

For clean energy technology to be adopted in nations that do not have the wealth to pursue higher-cost energy or technology, private sector investment is needed to find opportunities to reduce costs, discover profitable use cases and overcome barriers to adoption.

THE STATE OF PUBLIC AND PRIVATE SECTOR R&D

Levels of public funding for energy R&D have changed along with political priorities, and an escalating pressure to increase energy innovation spending from both parties has put upward pressure on its size and scope. As a result, from 2011 to 2020, publicly funded energy R&D has roughly doubled from $2.2 billion to $4.5 billion.[8] The biggest increases have occurred in energy efficiency and renewable energy research, but nuclear energy and fossil energy have also seen notable increases in public R&D spending. The graph below shows overall federal energy R&D by energy type, which illustrates the increase.

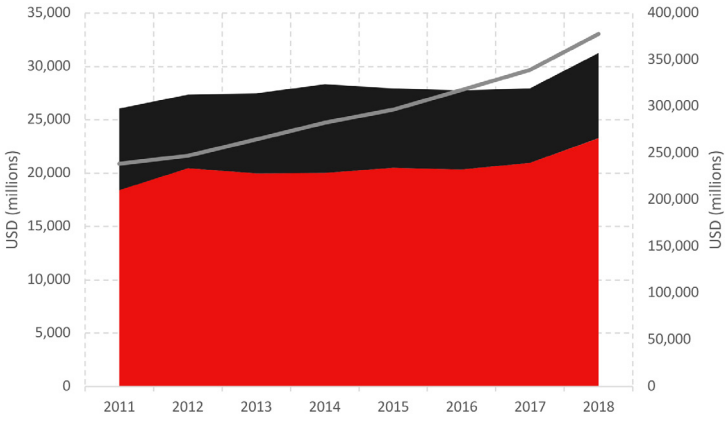
FIGURE I: ENERGY AND ENVIRONMENTAL FEDERAL R&D



Source: R Street graph created using National Science Foundation Federal R&D data by budget function.[9]

While public funding for E&E R&D has increased, private funding has not kept pace. Between 2011 and 2017 (the year before tax reform took effect), private sector economy-wide R&D funding (paid for and performed by companies) increased from $238.8 billion to $339 billion—an increase of 42 percent.[10] Over the same period, private R&D within the E&E sectors only increased from $26.1 billion to $28 billion, or 7 percent.[11] Even worse, most of the increase in private E&E R&D was between 2011 and 2012. When looking at the period between 2012 and 2017 the change was only $27.4 billion to $28 billion, or a mere 2 percent increase in E&E R&D spending.[12]

FIGURE 2: E&E R&D PAID FOR AND PERFORMED BY COMPANIES



Source: R Street graph created using National Science Foundation Business Enterprise Research and Development Survey, years 2011-2018, tables 30-31.[13]

5. "Federal Policies and Innovation," p. 15-16. https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/49487-Innovation.pdf.

6. "The Green Premium," Breakthrough Energy, last accessed May 12, 2021. https://www.breakthroughenergy.org/our-challenge/the-green-premium.

7. Kira Markiewicz et al., "Does Competition Reduce Costs? Assessing the Impact of Regulatory Restructuring on U.S. Electric Generation Efficiency," *SSRN*, November 2004, p. 30. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=618281.

8. "Federal R&D Funding, by Budget Function," National Science Foundation, Table 10, Years 2011-2021, August 2020. https://www.nsf.gov/statistics/srvyberd/#tabs-2.

9. Ibid.

10. "Business Enterprise Research and Development Survey," National Science Foundation, Tables 30-31, Dec. 16, 2020. https://ncses.nsf.gov/pubs/nsf21312#data-tables.

11. Ibid.

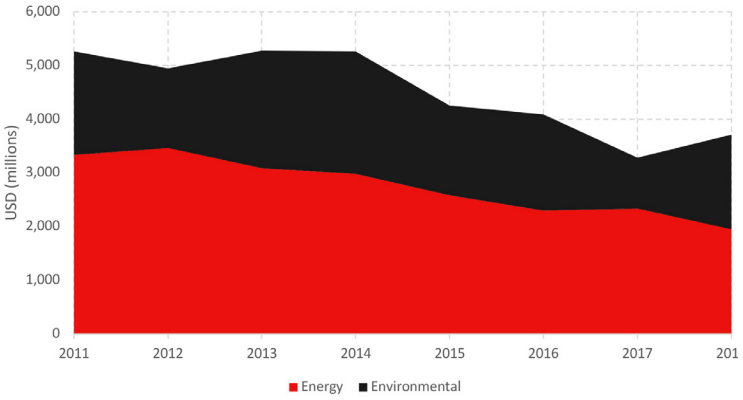
12. Ibid.

13. Ibid.

As demonstrated in Figure 2 above, in the year immediately following the adoption of the tax reform, private sector E&E R&D saw a substantial boost. Energy R&D increased by 10.9 percent from the prior year, and environmental R&D increased by 14.6 percent.[14] Put together, the increase was $3.3 billion, or 11.8 percent.[15] Even before the tax reform, though, private sector E&E R&D represented the lion's share of total E&E R&D, at nearly eight times the public spending in 2017 at $28 billion compared to $3.5 billion (and roughly 7.4 times the public spending in 2018, at $31.2 billion compared to $4.2 billion).[16] Consequently, because private sector R&D is so much greater in volume than public sector R&D, policies that focus on removing barriers to privately funded R&D may result in increases in net innovation investments.

Additionally, R&D paid for by others and performed by companies had an interesting response to the tax reform, with energy R&D paid for by others declining by 16 percent, but environmental R&D paid for by others increasing by 85 percent, resulting in a net increase of $430 million or 13.1 percent.[17] Figure 3 shows the total E&E R&D that companies performed, that was paid for by others, from 2011-2018. Note that this is separate from E&E R&D paid for and performed by companies (discussed above), and overall, this level of R&D has been in decline, except for the substantial increase in environmental-specific R&D supported after the tax reform.

FIGURE 3: E&E R&D PAID FOR BY OTHERS AND PERFORMED BY COMPANIES



Source: R Street graph created using National Science Foundation Business Enterprise Research and Development Survey data, Tables 30-31.[18]

The increase in E&E R&D following the tax reform generally tracked with economy-wide increases in R&D.[19] Specifically, there was an 11.4 percent change in economy-wide R&D ($38.8 billion) in 2018 that was a little less than double the prior year's change of 6.7 percent.[20] The jump in R&D investment is roughly consistent with the Congressional Budget Office's (CBO) estimated increase in overall business investment from 3.9 percent growth in 2017 to 8.5 percent in 2018.[21] The CBO also estimated that growth rates would fall to 2.5 percent in 2019, and given the temporary nature of some of the tax reform's incentives—as expensing for R&D is slated to end in 2022—it would make sense that innovation investment may be front-loaded and could fall when the 2019 data becomes available.[22] When later data becomes available, it will be important to determine if the changes in R&D in 2018 were merely the result of firms shifting later R&D to an earlier year.

As a caveat, it is still too early to tease out exactly how much and to what extent policies within and outside of the tax reform contributed to the observed increase in private sector R&D. Other policies were occurring at the time, such as regulatory reform, and technology transfer policies from the Department of Energy. Though given that the tax reform was among the largest economic events of the period (alongside the "trade war"), it may explain most of the changes.

However, even with rising privately funded E&E R&D in 2018, energy and environmental research represents a shrinking share of investment in the overall landscape of private R&D. As a ratio of total private sector R&D spending, E&E R&D has declined from a peak of 11 percent in 2012 to 8.3 percent in 2018, as is demonstrated in Figure 4 below.

14. Ibid.

15. Ibid.

16. Ibid.

17. Ibid.

18. Ibid.

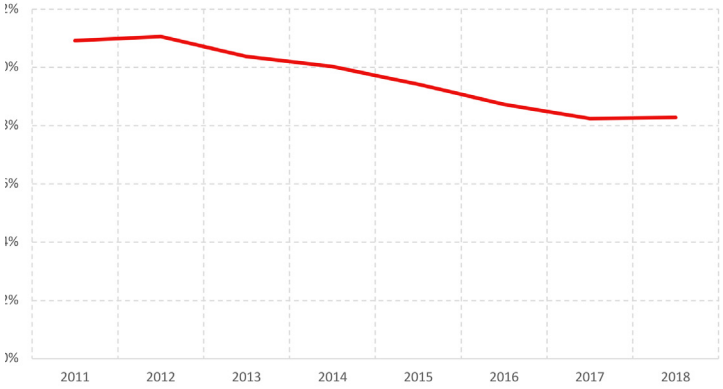
19. Ibid.

20. Ibid.

21. "The Budget and Economic Outlook: 2018 to 2028," Congressional Budget Office, April 2018, p. 20. https://www.cbo.gov/system/files/2019-04/53651-outlook-2.pdf.

22. Ibid.

FIGURE 4: E&E R&D SHARE OF TOTAL R&D



Source: R Street graph created using National Science Foundation Business Enterprise Research and Development Survey data, Tables 30-31.[23]

The data delivers two interesting points: there was a significant increase in private sector funding for E&E R&D in response to the tax reform, and E&E R&D is in decline as a share of total R&D investment. Because R&D values increased after the tax reform, there is a strong case to be made that the prior tax treatment had a deleterious effect on the incentives for the private sector to explore opportunities for E&E R&D.

The declining share of E&E R&D as a portion of total privately funded R&D could be due to multiple reasons. Optimistically, one could assume that the private sector identified higher value propositions that may have societal benefits, such as pharmaceuticals or information technology. Pessimistically, one could presume that expanded subsidies and mandates for mature energy technologies is crowding out private sector investment for the commercialization of new technology.

It is beyond the scope of this paper to speculate on the magnitude of either possibility in diminishing E&E R&D, but it is worth noting that if competing R&D opportunities is the better explanation, then that trend should have continued through 2018 rather than the slight increase in E&E R&D that was observed.

EFFECTS OF THE TAX REFORM ON PRIVATE SECTOR E&E R&D

Given that a key objective of the tax reform was to improve the tax treatment of R&D to stimulate productivity growth, it can claim some success.[24] Further, indices of the competitiveness of the U.S. tax code such as the noted improvement immediately following the tax reform. For example, the Tax Foundation upgraded the United States' international tax competitiveness score for corporate taxes from 35th overall (the bottom) to 20th overall.[25]

The effect on R&D following the tax reform is due to two primary changes in the tax code. The first is the corporate income tax (CIT) rate, which was lowered from 35 percent to 21 percent. Lower CIT rates incentivize increased investment in intangible and tangible assets and innovation by improving after-tax rates of return and allowing firms to recover costs earlier than they otherwise would. The second is the transition from amortization rules, especially for R&D, to expensing. Under the old rules, a firm's investment in new equipment would have its tax liability deducted gradually over time, but because of the net-present value of money (dollars today are worth more than dollars tomorrow) and inflation, this is an implicit disincentive on new investment. Conversely, the practice of expensing allows firms to deduct investments from their tax liability immediately, incentivizing them to invest more and earlier.

To maximize R&D that can offer environmental benefits, the complementary nature between public and private R&D should not be ignored. Only private R&D bears its own risk, and thus has incentives for seeking the most efficient opportunities to commercialize near-mature technology. The CBO notes that research supporting the rationale that public spending can facilitate technology commercialization (a later-stage process in R&D) is "at best mixed."[26] A centrally planned approach that aims to use taxes to raise revenues that could then be used to subsidize late-stage innovation is not a substitute for innovation that is arrived at through market forces and competition.

Simply, an inefficient tax code may be holding back the technological state of energy, as newer, cleaner energy technology that would otherwise be seeded in the market is never given an opportunity. Further, these invisible victims may hold more economic and environmental value than conventional efforts of subsidizing mature energy technologies.

POLICY IMPLICATIONS

While a good deal of research remains on the horizon in studying the relationship between various tax provisions in the tax reform and their impact on real-world R&D investment, the central point remains: the tax treatment of R&D is important for stimulating private sector R&D across the entire economy, including in the energy and environmental sectors.

23. "Business Enterprise Research and Development Survey." https://ncses.nsf.gov/pubs/nsf21312#data-tables.

24. Nathan Musick, "How Might Changes in Federal Policies Boost Innovation and Productivity?", Congressional Budget Office, March 2, 2017. https://www.cbo.gov/publication/52464.

25. "Taxes in the United States," Tax Foundation, last accessed May 24, 2021. https://taxfoundation.org/country/united-states.

26. Musick. https://www.cbo.gov/publication/52464.

The impact of the tax reform on E&E R&D in particular is noteworthy, since it indicates that inefficient tax treatment may be suppressing private sector innovation and resulting in forgone improvements to productivity. Further, given that private sector E&E R&D is over seven times larger than the spending on equivalent R&D from the public sector, tax policies that hinder private sector investment may be disproportionately harmful to environmental progress.

Policymakers that aim to shift tax burdens to businesses or investment should consider the effect of their policies on innovation. For example, research has shown that "wealth taxes" may have significant deleterious effects on economy-wide innovation.[27] When addressing a challenge like climate change, where many of the current clean energy technologies have limited substitutability with incumbent technologies, there is a real risk of such policies doing more harm than good.

Importantly, given the distinct differences between the role of private and public sector R&D, it should not be presumed that increased R&D spending or other subsidies for commercializing energy technologies is a feasible substitute for the benefits of pro-innovation tax policy. The CBO has noted that both publicly funded R&D for early-stage innovation and effective tax policies providing "financial incentives to individuals and businesses to pursue innovation" are key to improving economic productivity.[28] To this effect, this paper identifies four recommendations for policymakers:

1. Make permanent the tax reform's authorization of R&D expensing in lieu of R&D amortization, which would preserve the incentive for the private sector to invest in innovation.

2. Avoid the temptation to implement or restore taxes on capital to pay for public spending, as the harm to future productivity from the tax may outweigh the benefit of public spending.

3. Understand that transferring too much of the costs of mature energy and environmental technology to the public sector may crowd out private sector investment, as competing technologies would have to compete with subsidized technology to enter into market.

4. Do not neglect the comparative advantages of both private- and public-sector innovation; the private sector is better at scaling and commercializing near-mature technology with profitable applications, and the public sector is better at advancing not-yet-profitable technologies that may yield long-term societal benefits.

CONCLUSION

The tax reform is the most probable reason for a significant increase in private sector driven E&E R&D, increasing overall energy and environmental innovation investment by $3.3 billion in 2018. Overall, private sector E&E R&D outweighs publicly funded E&E R&D by a factor of over seven to one, so policies that result in even modest increases in privately funded innovation can increase net economy-wide investments at greater volumes than public spending. Further, privately funded R&D targets specific opportunities for commercializing near-mature technologies that may not be capturable by publicly funded innovation, meaning a government-managed approach to clean energy innovation is not an effective substitute for the role of the free market.

Policymakers would be wise to consider how their policies may improve or harm incentives for the private sector to invest in energy and environmental innovation. It may be tempting to view mandates or subsidies as additional investments, or a redirection of funds, but the reality is that these policies may be diminishing the appetite for investment from the private sector, and the United States could be missing opportunities for innovation that would otherwise be funded. When addressing significant global collective action problems such as climate change, which are best remedied with new technology that is deployable globally, policymakers should preserve incentives for innovation.

ABOUT THE AUTHOR

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27. Garret Watson, "Proponents of Wealth Taxation Must Consider its Impact on Innovation," Tax Foundation, Nov. 12, 2019. https://taxfoundation.org/wealth-tax-economic-impact.

28. Musick. https://www.cbo.gov/publication/52464.