Appendix A: Economic Model Methodology

States have enacted various tax incentives—credits, deductions, exemptions, exclusions, deferrals, or preferential rates—to spur economic development within their boundaries. These incentives are often accompanied by claims that the tax incentives pay for themselves, enable job creation, or safeguard a state's ability to remain competitive. Legislatures and policy analysts have only rarely subjected these assertions to empirical analysis, even though tax incentives can cost states significant amounts of foregone revenue.

Seeking to rectify this deficiency, The Pew Charitable Trusts—a nonpartisan and nonideological public policy research organization based in Washington, DC—launched an initiative in 2012 to encourage states to evaluate their tax incentives. Since 2012, the District of Columbia and at least 22 states, including Minnesota, have passed laws requiring evaluation of their economic development tax incentives to determine how well such incentives are achieving their goals.[1] Building on a methodology developed by Tim Bartik, a leading economic development researcher, The Pew Charitable Trusts developed an economic model to analyze the effects of state tax incentives.[2] We used Pew's economic model to produce some of the results presented in Chapter 2 of our 2017 evaluation, *Minnesota Research Tax Credit*.[3] In this appendix, we discuss the model's inputs, its methodology, and its limitations.

Main Data Inputs

Pew's economic model requires users to collect data for three main data points and to use other data available from published sources. In this section, we discuss how we obtained the three main data inputs. The remaining data, such as the total employment in Minnesota in particular industries, and their sources are noted where relevant in the following "Methodology" section, which details Pew's economic model's calculations.

The three main data elements needed for Pew's economic model, by industry and year, are:

- Total amount of research tax credit claimed, expressed in dollars
- Total number of employees at the incentivized companies

[1] For Minnesota's law, see *Laws of Minnesota* 2015, chapter 77, art. 2, sec. 2, codified in *Minnesota Statutes* 2016, 3.9735. The 2017 evaluation *Minnesota Research Tax Credit* is the first report produced by the Office of the Legislative Auditor in accordance with the statute.

[2] A version of the spreadsheet is available from The Pew Charitable Trusts to approved users at www.evaluatingincentives.org. The spreadsheet we used for our analysis was a modified version that allowed for Minnesota-specific analysis. We gratefully acknowledge the assistance of staff members at The Pew Charitable Trusts and of Timothy J. Bartik, Ph.D., senior economist at the W.E. Upjohn Institute for Employment Research.

[3] Office of the Legislative Auditor, Program Evaluation Division, *Minnesota Research Tax Credit* (St. Paul, 2017). The report may be accessed online at www.auditor.leg.state.mn.us or by calling 651-296-4708 to request a copy.

- Total wages paid to employees at the incentivized companies, expressed in millions of dollars

To obtain the total amount of research tax credit claimed, by industry and year, we used a database—described in Chapter 3 of *Minnesota Research Tax Credit*—that we built from the tax forms of C corporations that claimed the Minnesota research tax credit from 2010 to 2014.[4] For each research tax-credit claimant, the database includes the amount of research tax credit claimed in a given year and the company's self-reported business activity code.[5] We used the latter to determine each claimant's industry sector.

We determined that four industries accounted for 95 percent of the total amount of research tax credit dollars claimed by C corporations from 2010 to 2014. We assumed that the distribution of credit dollars among C corporations from 2001 to 2009 was the same as from 2010 to 2014.[6] Thus, we assumed for all years 2001 to 2014 that companies in the Manufacturing industry claimed 65 percent of the credit claimed by C corporations; companies in the Professional, Scientific, and Technical Services industry claimed 13 percent; companies in the Management of Companies and Enterprises industry claimed 13 percent; and companies in the Wholesale Trade industry claimed 4 percent. The remaining 5 percent of the credit claimed by C corporations was spread across 14 other industry sectors, each claiming 1.3 percent or less of the credit. We did not include those industries in our analyses involving the Pew economic model. To the extent that the actual pre-2010 distribution by industry of research tax credits differed from more recent years, our results could also differ.

We obtained the remaining two major data elements—the total number of employees at the incentivized companies and wages paid to those employees, by industry and year—by linking data from the Department of Revenue to data from the Department of Employment and Economic Development (DEED). The Department of Revenue provided us with the Federal Employee Identification Number (FEIN), by year, for each research tax-credit claimant from 2001 to 2014. We then obtained data from DEED's unemployment insurance database that allowed us to determine a head count of employees and the total wages paid to those employees for each combination of taxpayer and tax year.[7] Finally, we summed the employees and wages by industry for each year. We discuss limits and challenges to our analysis in the "Limitations" section at the end of this appendix.

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[4] As we note in Chapter 3 of *Minnesota Research Tax Credit*, similar data were not available for S corporations and partnerships.

[5] A business activity code is a number up to six digits that a business self-reports on its tax return to identify its industry sector. The codes come from the North American Industrial Classification System (NAICS). We classified businesses into industry sectors based on the first two digits of their NAICS code, which is the broadest grouping of industry sectors.

[6] We obtained data from the Department of Revenue on the amount of research tax credit claimed from 2001 to 2014. In our report, we present our findings from 2008 to 2014. These more recent years reflect the period just before the Legislature made the credit refundable (2008-2009), the period the credit was refundable (2010-2012), and the first years after the Legislature repealed refundability (2013-2014).

[7] All employers in Minnesota who pay unemployment insurance tax must report certain data about their employees to DEED's unemployment insurance database on a monthly basis. Among the data points included in the database are the number of employees and the wages paid to each employee of a given employer. The database covers approximately 97 percent of Minnesota employees, but it excludes proprietors, self-employed persons, railroad workers, family farm workers, full-time students who work for their school, elected government officials, insurance and real estate salespeople, and others who work on a commission basis only. Most partnerships are not required to report to the unemployment insurance database and, consequently, do not do so.

Methodology

Pew researchers based their economic model on findings from academic literature regarding how businesses respond to reduced costs. The model estimates the increased business outputs, such as jobs, resulting from companies receiving the incentive. This is the direct effect of Minnesota's research tax credit. Using multipliers, the model estimates the indirect effects of a tax incentive.[8] Finally, the model accounts for certain opportunity costs.[9] We used the model to estimate the direct and indirect effects for each industry based on industry-specific data.

Reduction in Business Costs

Using state- and industry-specific data, the model calculates how much the research tax credit reduces business costs for firms receiving the incentive. This involves two main steps.

First, the model calculates the average value added per employee for the industry.[10] We obtained Minnesota data on industry employment and value added from the federal Bureau of Economic Analysis, a division within the U.S. Department of Commerce.

The model uses the following equation to calculate the value added per employee for year *y* in incentivized industry *i*:

$$value\ added\ per\ employee_{yi} = \frac{(value\ added\ in\ Minnesota_{yi})}{(total\ employment\ in\ Minnesota_{yi})}$$

Second, the model uses the value added per employee to calculate the percentage reduction in business costs within the incentivized companies due to the research tax credit. The following is the equation for calculating the percentage reduction in business costs for year *y* in incentivized industry *i*:

$$percentage\ reduction\ in\ business\ costs_{yi} = \frac{-(amount\ of\ incentive_{yi})}{(total\ employment\ at\ incentivized\ companies_{yi}) \times (value\ added\ per\ employee_{yi})}$$

Direct Effects on Business Output

The model calculates the direct effects of the research tax credit on business output at the incentivized companies.[11] It does this by applying findings from academic research regarding the relationship between reduced business costs and subsequent business outputs.

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[8] A multiplier is an estimate of the effect that increased employment or earnings in incentivized companies will have on employment or earnings in companies that did not receive the tax incentive. The effects are called "indirect effects" because they happen to businesses that do not receive the tax incentive directly.

[9] Opportunity costs are the tradeoffs that occur because a state chooses to pursue one policy rather than another. For example, if a state chooses to forego revenue by providing a tax credit, the state will have to either cut spending or raise taxes to balance its budget. Either option has consequences on the effects of the tax incentive.

[10] Value added is roughly equivalent to total business costs.

[11] Direct effects are the changes to employment and earnings at the businesses that directly receive the tax incentive.

Elasticity, export share, and speed of adjustment—concepts we explain below—describe how businesses respond to tax incentives.

Elasticity is a measure of how sensitive businesses are to changes in costs. With reduced costs, a business can maximize profit by increasing output, and therefore increasing employment. Academic research suggests that the plausible range of outcomes from a 1 percent reduction in business costs is a 1 percent to 12 percent increase in business outputs, with the average being a 4 percent increase.[12] Consequently, our calculations use an elasticity of 4 percent for all industries in all years.

Export share refers to the portion of goods and services that are sold outside of the local economy for businesses in a particular industry. This parameter is important because, for companies with low export shares, increased hiring at an incentivized company may come at the expense of another local company. This offsets the benefit of the incentive. Thus, incentives that target primarily businesses selling goods and services locally may generate displacement in the local economy. Incentives that target businesses providing goods or services nationally or internationally will have lower displacement effects.

Pew's economic model offers default values for each industry's export share. The values are based on an industry's "location quotient," which is the share of a state's employment in the industry relative to national employment in the same industry. Pew researchers calculated the standard deviation for each 6-digit North American Industrial Classification System (NAICS) industry's location quotient across U.S. metropolitan statistical areas to determine the export share. A standard deviation near 0 indicates a locally based industry, and a larger standard deviation indicates an industry more reliant on exports. Using a standard deviation of 1.5501 as a cutoff, researchers assigned a value of 0 to local industries and a value of 1 to export-based industries. They then averaged those values for 6-digit NAICS industries up to the 2-digit NAICS code level to determine an export share for each industry. For our analysis, we used the following export shares by industry:

- Manufacturing: 90 percent[13]
- Professional, Scientific, and Technical Services: 8.2 percent
- Management of Companies and Enterprises: 50 percent[14]
- Wholesale Trade: 21.5 percent

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[12] Timothy J. Bartik and Kevin Hollenbeck, "An Analysis of the Employment Effects of the Washington High Technology Business and Occupation (B&O) Tax Credit: Technical Report," Upjohn Institute Working Paper 12-187 (Kalamazoo, MI: W.E. Upjohn Institute for Employment Research, 2012); and Michael Wasylenko, "Taxation and Economic Development: The State of the Economic Literature," *New England Economic Review* (1997): 49.

[13] The Pew Charitable Trusts provides separate export share values for "durable goods manufacturing" (92.9 percent) and "nondurable goods manufacturing" (81.8 percent). Because we used one consolidated "manufacturing" category in our analysis, we chose an intermediate value for that industry's export share.

[14] The Pew-assigned export share value for Management of Companies and Enterprises is 0.9 percent, but is based on a national average. We examined Minnesota research tax-credit claimants in this industry. The claimants included several well-known companies that have a large, national presence. Further, Minnesota has an unusually large share of employment in this industry compared to other states, suggesting that the industry is meeting more than just local need. Therefore, we determined it was appropriate to raise the export share for that industry well above the default value provided by Pew.

Speed of adjustment refers to how quickly businesses respond to reduced costs. If a tax incentive ultimately results in a company maximizing its profit at a higher level of output, it cannot instantaneously adjust to that new level. It takes time to hire workers and expand capital. Research suggests that incentivized companies typically adjust annually by 9 percent of the difference between their current business activity and the new level of activity.[15] If, for example, a tax incentive ultimately results in a new level of output of 4 percent above a company's previous level of activity, the firm would increase output by 0.36 percent in the first year (4 percent × 9 percent = 0.36 percent). Over time, the increase in output will rise until it reaches 4 percent.

Pew's model uses the direct effects of a tax incentive on employment as a proxy for the direct effects on business output. The following equation estimates the direct effects of the research tax credit on employment by accounting for elasticity, export share, and the speed of adjustment for year y and for companies in incentivized industry i:[16]

$$\begin{aligned} direct\ effects\ on\ employment_{yi} &= \left(percentage\ reduction\ in\ business\ costs_{yi}\right) \times (elasticity) \\ &\times (export\ share_i) \times (speed\ of\ adjustment) \\ &+ \Bigg[(1 - speed\ of\ adjustment) \\ &\times \left(direct\ effects\ on\ employment_{(y-1)i}\right) \\ &\times \frac{total\ employment\ at\ incentivized\ companies_{(y-1)i}}{total\ employment\ at\ incentivized\ companies_{yi}}\Bigg] \end{aligned}$$

Indirect and Induced Effects on Employment

The model uses **employment multipliers** to determine the "indirect" and "induced" effects of the tax incentive on statewide employment. An indirect effect occurs when an incentivized firm buys more goods and services from an in-state business, and that business, in turn, increases its hiring. An induced effect occurs when an incentivized firm pays its employees more and those employees increase their spending in the local economy.

We purchased employment and earnings multipliers from the Bureau of Economic Analysis's Regional Input-Output Modeling System (RIMS II).[17] The RIMS II multipliers are state- and industry-specific. The multipliers account for direct, indirect, and induced effects. A multiplier of 2.3 indicates that the total increase in economic activity due to the tax incentive will be 2.3 times the direct effects. In other words, the indirect and induced

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[15] L. Jay Helms, "The Effect of State and Local Taxes on Economic Growth: A Time Series-Cross Section Approach," *The Review of Economics and Statistics* 67, no. 4 (1985): 579.

[16] The portion of the equation in brackets, which relies on model outputs for the preceding year, is omitted for the first year of an analysis.

[17] RIMS II provides two kinds of multipliers. We used Type II multipliers, which account for changes in both interindustry and household spending related to an incentive. Type I multipliers account for only interindustry effects. The RIMS II multipliers are the proprietary data of the federal Bureau of Economic Analysis. Consequently, we treat them as "not public" data and do not reveal the values we used in our analysis.

effects are 1.3 times the direct effects. To isolate the indirect and induced effects, the Pew economic model subtracts 1 from the multiplier.[18]

The equation for determining the research tax credit's indirect and induced effects on employment for year *y* in industry *i* is as follows:

$$\begin{aligned} &indirect\ and\ induced\ effects\ on\ employment_{yi} \\ &\quad = (direct\ effects\ on\ employment_{yi}) \\ &\quad \times (employment\ multiplier_i - 1) \end{aligned}$$

Net Change in Employment

In addition to the direct and indirect/induced effects of a tax incentive, Pew's economic model also accounts for opportunity costs. When a state chooses to forego revenue as part of a tax credit, Pew's model assumes the state either cuts spending or increases taxes to balance the budget. Had the state hypothetically either increased spending or enacted a broad-based tax cut, either could have had a stimulating effect on the economy. The effect of those hypothetical alternative scenarios must be subtracted out of any positive effects a tax incentive achieves.

Both tax increases and spending cuts reduce demand in the economy, slowing growth. An increase in business taxes to pay for incentives increases costs and therefore can reduce hiring. Spending cuts can have a negative impact on the qualified labor supply if those cuts impact education. We entered these effects into Pew's model by estimating the share of the research tax credit that is funded by tax increases, the percentage of those tax increases that is levied on businesses, and the share of spending cuts that affect elementary and secondary (K-12) education.[19]

To make a conservative estimate, we assumed that 50 percent of the research tax credit is funded by tax increases and 50 percent is funded by spending cuts. We assumed that 39 percent of that tax increase is levied on businesses.[20] Last, we assumed that 40 percent of spending cuts affected K-12 education.[21]

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[18] By definition, the research tax credit's indirect effects on employment are those that occur beyond the incentivized companies; they are statewide effects on jobs.

[19] Cuts to K-12 spending may have long-term effects on the labor market, including lower earnings for the affected students and a lower likelihood of entering or staying in the work force. Timothy J. Bartik, *Investing in Kids: Early Childhood Programs and Local Economic Development* (Kalamazoo, MI: W.E. Upjohn Institute for Employment Research, 2011).

[20] We make this assumption based on an analysis by Ernst & Young, which determined that business taxes amounted to $13.4 billion out of $34 billion of state and local taxes paid in Minnesota in fiscal year 2015. Therefore, we are assuming that any tax increase used to pay for the research tax credit is levied proportionally to the current distribution of taxes in Minnesota. Andrew Phillips, Caroline Sallee, and Charlotte Peak, *Total State and Local Business Taxes: State-by-State Estimates for Fiscal Year 2015* (Washington: Ernst & Young LLP, 2016), 13.

[21] We based this assumption on an analysis by the Kaiser Family Foundation, which found that 40.3 percent of Minnesota's general fund expenditures in fiscal year 2015 related to elementary and secondary education. We are assuming that any spending cuts used to pay for the research tax credit affect all general fund expenditures proportionally. See *Distribution of State General Fund Expenditures* (Menlo Park, CA: The Henry J. Kaiser Family Foundation, 2015), http://kff.org/other/state-indicator/distribution-of-general-fund-spending, accessed January 10, 2017.

Pew's economic model uses a series of formulae to calculate the statewide effects of a tax incentive on statewide employment by taking into account direct effects, indirect and induced effects, and opportunity costs. We present the main equation below.

$$\begin{aligned} net\ change\ in\ employment_{yi} \\ &= \left(indirect\ and\ induced\ effects\ on\ employment_{yi}\right. \\ &\times \left. total\ employment\ at\ incentivized\ companies_{yi}\right) \\ &+ \left(direct\ effects\ on\ employment_{yi}\right. \\ &\times \left. total\ employment\ at\ incentivized\ companies_{yi}\right) \\ &+ \left(employment\ change\ due\ to\ opportunity\ costs_{yi}\right) \end{aligned}$$

Net Change in Earnings

As with the net change in employment, the Pew economic model uses a series of formulae to account for the direct effects, indirect and induced effects, and opportunity costs of a tax incentive on the net change in earnings statewide. We present the main equation below.

$$\begin{aligned} net\ change\ in\ earnings_{yi} \\ &= \left(\left(direct\ effects\ on\ employment_{yi} \times \left(earnings\ multiplier_i - 1\right)\right)\right. \\ &\times \left. earnings\ at\ incentivized\ companies_{yi}\right) \\ &+ \left(direct\ effects\ on\ employment_{yi}\right. \\ &\times \left. earnings\ at\ incentivized\ companies_{yi}\right) \\ &+ \left(earnings\ change\ due\ to\ opportunity\ costs_{yi}\right) \end{aligned}$$

Net Fiscal Cost

To calculate an incentive's net fiscal cost to the state as a whole, the Pew economic model considers the incentive's effects on population and personal income. Changes in population, such as what happens when people move to a state to fill newly available jobs, have an impact on governments' revenues and expenditures. New residents bring additional tax dollars to the state, but they also bring additional needs for public services, which can increase costs to the state. Similarly, changes in current state residents' incomes as a result of the incentive will affect state revenues.

The Pew economic model uses a series of formulae to estimate population changes, personal income changes, and the net fiscal cost of an incentive. These calculations rely on data about state revenues and expenditures, which we obtained from the nonpartisan Urban Institute-Brookings Institution Tax Policy Center.[22]

[22] *State & Local Government Finance Data Query System*, (Washington, DC: Urban Institute-Brookings Institution Tax Policy Center, 2016), http://slfdqs.taxpolicycenter.org, accessed November 30, 2016.

The equation for fiscal benefit or cost in year *y* and incentivized industry *i* is:

$$\begin{aligned} fiscal\ benefit\ or\ cost_{yi} \\ &= (percentage\ change\ in\ log\ state\ population_{yi} \\ &\times coefficient\ for \log change\ in\ population_y) \\ &+ (percentage\ change\ in\ personal\ income_{yi} \\ &\times coefficient\ for \log change\ in\ personal\ income_y)^{23} \end{aligned}$$

The equation for net fiscal cost in year *y* for incentivized industry *i* is:

$$\begin{aligned} net\ fiscal\ cost_{yi} \\ &= (amount\ of\ the\ research\ tax\ credit_{yi}) \\ &- (fiscal\ benefit\ or\ cost_{yi}) \end{aligned}$$

Limitations

Our analysis has several limitations related to our assumptions and issues we experienced with data. As noted throughout this appendix, our analysis relies on a series of assumptions—particularly those related to elasticity, export share, speed of adjustment, earnings and employment multipliers, and opportunity costs. We found that our estimates were sensitive to these assumptions. We have explained why we made the assumptions we did, but other analysts may reasonably rely on different assumptions and arrive at different conclusions.

We faced a number of data challenges as well. Our analysis included only C corporations. We could not determine the distribution of research tax credit claims by industry for S corporations and partnerships because, as we discussed in Chapter 3 of *Minnesota Research Tax Credit*, the tax forms we needed for our analysis were largely not available. Consequently, we could not apply the Pew economic model to S corporations and partnerships. As a result, we were unable to estimate the full effects of Minnesota's research tax credit. Despite this limitation, we decided to proceed with our analysis because C corporations account for approximately 81 percent of the amount of research tax credits claimed since 2010. They accounted for 100 percent of the amount of research tax credits claimed from 2001 to 2009.[24]

A second data limitation is that we had to rely on an imperfect link between data collected by the Department of Revenue and data collected by DEED. Because information contained in tax forms, including both FEINs and the fact that a taxpayer claimed the research tax credit, is "not public" information, we had to use a circuitous and inefficient process to link the data from the Department of Revenue with the data from DEED. Additionally, because DEED does not have business reasons for analyzing data at the FEIN

[23] A logarithm ("log") is the power to which a base number must be raised to produce a given number; it is the inverse of exponentiation. For instance, the equation $2^3 = 8$ can be expressed in logarithmic form as $\log_2(8) = 3$. In this example, 3 is the power to which a base of 2 must be raised to produce 8. The formulae in Pew's economic model use natural logarithms, which have a base of *e*; *e* is an irrational constant approximately equal to 2.72 and is widely used in mathematics.

[24] Shareholders in S corporations and individual partners in partnerships were not eligible for the research tax credit from 2001 to 2009.

level, it has no requirements for how employers should report into the unemployment insurance database using their FEIN. Consequently, such reporting lacks consistency.

A third data limitation is that we had to use wages as a proxy for business costs. Wages generally account for 70 percent of business costs and were the best data point available.

A fourth data limitation is that we used statewide data for our analyses. Our survey of research tax-credit claimants shows that, among our respondents, most of their Minnesota research is done in the Twin Cities metropolitan area. An analysis using data focused on the seven-county metropolitan area may produce different results.

A fifth data limitation is that we did not have data on the total amount of research tax credits claimed as would be reflected by amended or audited tax returns. We learned from our interviews with tax-credit claimants and from our review of a sample of audit files that audited taxpayers often have their research tax credits changed as a result of an audit. Some businesses reported spending more money hiring accountants to support them through an audit than they received as a tax credit. For such businesses, it would not be appropriate to treat the research tax credit as a reduction in business costs, as the Pew economic model does.