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# An Analysis of the Employment Effects of the Washington High Technology Business and Occupation (B&O) Tax Credit: Technical Report

**Upjohn Institute Working Paper No. 12-187**

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## ABSTRACT

This paper estimates the effects of an R&D tax credit in the state of Washington on job creation. The research uses micro-data on the job creation and tax credits received by individual firms in the state of Washington from 2004 to 2009. We correct for the endogeneity of R&D tax credits received by individual firms by using instrumental variables based in part on national industry factor shares for R&D. We estimate that this tax credit created jobs, but at a high cost. The cost per job-year created is estimated to be between $40,000 and $50,000. The credit was so high cost in part because the credit was non-refundable. As a result, about one-quarter of the firms receiving credits were maxed out on credit eligibility, so that the credit provided no marginal incentive for additional R&D spending or job creation.

**JEL Classification Codes**: R38, H71, J23

**Key Words**: R&D tax credits; business incentives; state economic development policies; job creation

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## INTRODUCTION

This paper analyzes the employment impact of the state of Washington's tax credit for research and development expenditures. The data used for the analyses are administrative tax records and supporting documents and administrative wage record data for all firms that received this credit from 2004 to 2009. These data sources were used to construct a six-year panel data set for individual firms that contains information on, among other things, employment and whether the R&D tax credit was received. Using estimates that properly control for the endogeneity of business receipt of this tax credit, we find that this tax credit creates some jobs, but at a high cost per job created. Our estimates are consistent with the overall research literature on the effects of business taxes on state and local business activity.

The R&D tax credit was begun by the state of Washington in 1994. The purpose of the tax credit is to "encourage the formation of high-wage, high-skilled jobs," according to the Washington legislature. Such jobs are believed by the Washington legislature to be "vital to the economic health of the state's citizens."

The tax credit is explicitly designed to reward businesses that are particularly research-intensive. To qualify for the tax credit, businesses must spend more than the average business does on R&D. This threshold is calculated by comparing the business's R&D spending with its taxable base for the main Washington State business tax, which is a tax on gross receipts from state of Washington sources. Firms are potentially eligible for the R&D tax credit if their R&D spending exceeds 0.92 percent of their taxable gross receipts; the legislature expressed the belief that this percentage was an average R&D spending rate for business.

Over the time period considered by this study (2004–2009), a firm's R&D tax credit depended on R&D spending, the firm's industry, the year, and some caps on the credit. From 2004–2006, the R&D credit rate for uncapped firms was equal to the firm's gross receipts tax rate times the excess of the firm's qualified R&D spending over 0.92 percent of the firm's taxable gross receipts. The firm's gross receipts tax rate varied by industry. For example, the gross receipts tax rate was 0.471 percent for retail firms, 1.8 percent for service industry firms, and 0.484 percent for manufacturing, wholesaling, and extraction industry firms. From 2007–2009, a floor was added to the credit rate. The R&D credit rate for uncapped firms was the maximum of the firm's gross receipts tax rate or an alternative rate (0.75 percent for 2007, 1.0 percent for 2008, and 1.25 percent for 2009). For all years from 2004 to 2009, the R&D credit received by an individual firm was capped in two ways. One cap was that no firm could receive more than $2 million in credits annually. A second cap was that the credit was nonrefundable, so the R&D credit could not exceed the firm's tax liability under the gross receipts tax.

The R&D credit applied only to "qualified" R&D spending. However, "qualified" was defined broadly. Qualified R&D activity was "research and development performed within this state in the fields of advanced computing, advanced materials, biotechnology, electronic device technology, and environmental technology." Spending eligible for the credit included operating expenses of the R&D, including wages and benefits, supplies, and computer expenses, but not including capital costs. The R&D activity had to be either directly conducted by the firm, or subcontracted to a public educational or research institution.

The design of this R&D credit has several consequences for how we conducted our research. First, the caps mean that there is often a big difference between average R&D credit rates and marginal R&D credit rates. By average credit rates, we mean the R&D credit for the firm as a percentage of the firm's R&D spending. By marginal credit rate, we mean the percentage the credit is of additional R&D spending by the firm, for a small increment in R&D spending. Because of the caps, there are firms with a zero percent marginal credit rate that still have a significant average R&D credit rate.

For most existing firms, the marginal credit rate is likely to be a more important determinant of job creation decisions. The modest credit provides some incentive for a research-intensive firm to expand a little more, by lowering its R&D costs. The magnitude of this incentive is given by the marginal credit rate, not the average credit rate. The average credit rate is a relevant incentive for firms that might be considering total shutdown as an option.

For the goal of obtaining precise estimation, it is fortuitous that the marginal credit rate is likely to be a more important determinant of firm behavior than the average credit rate. For the average credit rate, one consequence of the R&D credit design is the difficulty of precise estimation because of limited variation. The average credit rate varies only modestly across industries or over time. But plausible estimation might control for industry effects or even firm effects, as well as for time effects, so the modest variation of the average credit rate across industry or time likely means that any estimation that controls for industry or firm effects, and for time effects, will probably yield imprecise estimates.

On the other hand, there is much more statistically relevant variation in marginal credit rates. Marginal credit rates vary greatly over time across the different firms, due in large part to the caps. As will be seen later in this paper, this allows for much more precise estimation, even after controlling for firm and time effects.

As we will review in more detail later, one of the key problems in estimating the effects of any economic development tax incentive is that such incentives are endogenous. By “endogenous,” we simply mean that the magnitude of these incentives depends upon the firm’s growth, which makes it difficult to infer the causal effects of incentives on job creation from observed correlations between incentives and job creation. The magnitude of effects of any economic development incentive is likely to depend on the percentage reduction it induces in the firm’s overall costs of job creation. (See the methodology section, below, for more discussion of this point.) These percentage effects on the firm’s costs depend on the dollar magnitude of the incentives received by the firm. Yet the dollars of incentives received by the firm are likely to depend on the firm’s job creation. For example, the dollars in Washington R&D tax credits received by an individual firm will go up for firms that are expanding and therefore spending more on R&D. A positive correlation between a firm’s tax credit dollars received and the firm’s job creation may reflect causation in either direction.

As we will describe, we make careful efforts to correct for the endogeneity of the R&D tax credit variable through the use of instrumental variables. This estimation approach makes a great deal of difference to our results. The results correcting for endogeneity bias yield more sensible estimates than do results from uncorrected models.

The plan of the paper is as follows. The next section reviews the previous literature on effects of business tax incentives on state and local business activity. The section following that one develops our methodology and estimation equations in more detail. We then describe our data, present our estimates, and give our conclusions.

## REVIEW OF THE INCENTIVES-RELATED RESEARCH LITERATURE

The effects of incentives have been estimated in many publications. A much more extensive research literature has examined how state and local business activity is affected by overall state and local business taxes. The overall business tax research is relevant to incentives research because it seems plausible that the effects of both incentives and business taxes would depend upon their effects on business costs.

Most incentives research does not find much effect on state or local business activity. Buss (2001) provides a review. More recent papers that do not find much effect include Byrne (2010); Calcagno and Thompson (2004); Chirinko and Wilson (2010a,b); Dye and Merriman (1999); Elvery (2009); Gabe and Kraybill (2002); Greenbaum and Landers (2009); Hansen and Kalambokidis (2010); Hicks and LaFaive (2011); Lee (2008); Luger and Bae (2005); Lynch and Zax (2010); Mason and Thomas (2010); Merriman, Skidmore, and Kashian (2007, 2011); Neumark and Kolko (2010); Peters and Fisher (2002); and Weber, Bhatta, and Merriman (2003). However, some recent papers do find some substantively large and statistically significant effects of incentives. Customized job training incentives have some supportive research behind them (Hollenbeck 2008; Holzer et al. 1993; Hoyt, Jepsen, and Troske 2008). Manufacturing extension services have some research support (Jarmin 1998, 1999; MEP 2010). The federal Empowerment Zone program is found to have significant effects in one study (Busso, Gregory, and Kline, forthcoming). Job creation tax credits have one study in support of them, done by Faulk (2002).

However, incentives are typically quite small when measured as a share of business costs. This small share implies small effects of incentives on state or local business activity, which makes it more difficult to detect statistically significant effects. These small true effects of incentives may also be easily masked by any estimation biases. In particular, as we discuss in the methodology section, incentive effects may be biased by the endogeneity of incentives, since the dollar magnitude of incentives increases with increased state or local business activity.

The extensive research literature on the effects on state or local business activity of overall state and local taxes has been reviewed by Bartik (1991, 1992), Phillips and Goss (1995), and Wasylenko (1997). Overall business tax effects may be easier to accurately detect than incentive effects, because state and local business taxes are a larger share of business costs than business incentives. State and local business tax effects on business activity should be larger, and therefore easier to detect. Biases due to endogeneity effects may not loom as large.

Based on these reviews of the literature, the range of estimates for the long-run elasticity of state or local business activity with respect to overall state and local business taxes is from −0.1 to −0.6. State and local business taxes average around 5 percent of overall business costs. Therefore, assuming that business tax effects are due to the effects of business taxes on costs, the implied elasticity of state or local business activity with respect to overall business costs would be in the range of −2 to −12.

The research literature on how local wages affect local business activity implies a somewhat lower effect of business costs on business activity. The average elasticity of local business activity with respect to local wages is −0.7. Labor is about 70 percent of business costs. This implies an elasticity of state and local business activity with respect to overall costs of −1.0. However, it seems plausible that many studies of wages may underestimate the effects of wages on business activity. Wages will tend to go up when business activity goes up. This endogeneity bias will tend to bias estimated wage effects towards zero. Therefore, minus one may be viewed as a lower bound to the estimated effects on local business activity of variations in overall business costs.

These cost elasticities have implications for plausible ranges of the effects of incentives on local business activity. Suppose, as we will argue in the methodology section below, that the effect of incentives, business taxes, or other cost factors on local business activity is roughly proportional to effects on overall business costs. Then if the effect of an incentive on overall business costs is calculated, this allows a rough gauge of a plausible long-run effect of that incentive on state and local business activity.

## METHODOLOGY

Relative to overall business costs—even in research-intensive firms—the Washington R&D credit is quite small. To detect its effects, we have to be careful in specifying the estimating equation so that we accurately capture how its effects would vary across different firms' circumstances.

The underlying assumption in our specification is that the magnitude of output of a particular firm in the state of Washington depends on profits. Specifically, we assume that the natural logarithm of output will depend on the natural logarithm of the expected profits of the firm. That is, a shock to profits will engender a percentage change in employment that varies directly with the percentage change to profits.

We assume factor substitution effects are of secondary importance. This assumption can be justified by calculations by Bartik (1991, pp. 214–215). These calculations show that for factor demand dependent variables, such as employment, the effects of overall local costs on local employment are likely to be considerably greater in magnitude than the factor substitution effects of changes in the relative price of labor versus other factors of production. As a result of our assumptions, a firm's employment, or other variables, will also be assumed to have the same type of relationship to local costs as the firm's output. That is, the natural logarithm of the firm's employment, or earnings, will vary directly with the natural logarithm of the firm's expected profits.

Therefore, we assume that ln(employment) can be written as a linear function of the natural logarithm of profits:

(1) $$\ln\left(E_{ft}\right) = B_{10} + B_{11} \ln\left(\pi_{ft}\right) + e_{ft1} \quad .$$

$E_{ft}$ is employment of firm *f* in year *t*, $\pi_{ft}$ is profits of firm *f* in year *t*, and $e_{ft1}$ is an error term. Profits are defined as revenue minus costs, or

(2) $$\pi_{ft} = P_{yft} * Y_{ft} - \sum_{i} P_{ift} * X_{ift} \quad .$$

$P_{yft}$ is the price of output for the firm, $Y_{ft}$ is output for the firm, $P_{ift}$ is the price of input *i* for the firm, and $X_{ift}$ is the quantity of input *i* for the firm. Then the derivative of the natural logarithm of profits with respect to the natural logarithm of any input price will be equal to

(3) $$\frac{\partial \ln\left(\pi_{ft}\right)}{\partial \ln\left(P_{ift}\right)} = \left(\frac{P_{ift} * X_{ift}}{C_{ft}}\right)\left(\frac{C_{ft}}{\pi_{ft}}\right) \quad .$$

$C_{ft}$ is total costs for the firm—that is, the sum of the expenditures on all inputs. This equation is derived by applying the envelope theorem to the definition of profits.

The ratio of costs to profits is constant for all input prices for all homogeneous production functions (Lau 1978). Therefore, the effects of a percentage shock to any input price is to cause a percentage shock to profits whose magnitude is proportional to the factor share of that input in total costs.

We can use a Taylor series expansion of the logarithm of profit term in Equation (1) to re-express the log of employment as a linear function of the vector of log factor prices. Therefore, for plausible production function parameters, the logarithm of employment in a state will have a linear estimation equation in the logarithm of factor prices, where the logarithm of each factor price is weighted by that input's factor share for that particular firm.

However, in our cases, we are focusing on one factor price, the price of R&D. Therefore, we assume that the natural logarithm of the firm's employment depends on the natural log of the price of R&D, on other features of Washington such as the log of other factor prices, and on year effects. Other factors are summarized by a dummy variable for the firm, as we have multiple observations for each firm. Year effects are summarized by a dummy variable for the year over all firms. This leads to the following equation:

$$\begin{aligned}(4)\qquad \ln\left(E_{ft}\right) &= B_{40} + B_{41}\left\{\left[\left(P_{r\&dft} * X_{r\&dft}\right)/C_{ft}\right] * \left[\ln\left(P_{r\&dft}\right)\right]\right\} \\ &\quad + F_f + F_t + e_{4ft} \quad .\end{aligned}$$

$P_{r\&dft}$ is the price of R&D to the firm, $X_{r\&dft}$ is the quantity of R&D used by the firm, and therefore ($P_{r\&dft}*X_{r\&dft}/C_{ft}$) is the R&D factor share for the firm, $F_f$ and $F_t$ are fixed effects for the firm and year, and $e_{4ft}$ is the error term for this equation, expressing other employment determinants such as local wages, other taxes, etc. Thus, we are saying that the coefficient on ln(R&D factor price) will be a constant across some sample of firms if we weight that variable by the R&D factor share for that particular firm.

We do not observe the price of R&D. However, we do observe the R&D tax credit, which affects the price of R&D. Specifically, the natural logarithm of the net after-tax credit price of R&D will depend on the before-tax price of R&D and the tax credit, as described by the following equation:

$$(5)\qquad \ln(P_{r\&dft}) = \ln\left(P_{gr\&dft}\right) + \ln\left(1 - CREDIT_{ft}\right) \quad .$$

ln($P_{gr\&dft}$) is the ln of the gross R&D price before the Washington credit, and $CREDIT_{ft}$ is the credit rate facing the firm. We assume that the gross R&D price varies in three ways: 1) across firms, 2) over time, and 3) across firms *and* over time, but that its variation in the third way, across firms and over time, is uncorrelated with the credit rate. Therefore, we can substitute Equation (5) into Equation (4), and the gross R&D price term will be absorbed by the fixed effects for firm effects or year effects, and by the error term, without biasing the estimation.

After substitution, we get something closer to an estimating equation:

$$\begin{aligned}\ln\left(E_{ft}\right) = B_{60} + B_{61}\left\{\left[\left(P_{r\&dft} * X_{r\&dft}\right)/C_{ft}\right] * \ln\left(1 - CREDIT_{ft}\right)\right\} \\ + F_f + F_t + e_{6ft} \quad .\end{aligned} \tag{6}$$

The point of this specification discussion is that the R&D tax credit variable should be specified as weighted by the factor share of R&D in overall costs. This specification results in a coefficient, $B_{61,}$ that we would expect to be roughly constant across different firms, but only after the ln(1 − $CREDIT_{ft}$) variable for each firm is weighted by each firm's factor share for R&D spending. The specification implies that for small changes in the credit rate, we would expect effects on firm employment to be proportional to credits claimed as a percentage of total business costs. This is a restriction that aids in estimation, as it means our right-hand-side variable is varied across firms because of their R&D intensity.

To proceed with the estimation, we need to address the possibility of lagged adjustment to factor prices. The simplest alternative is to assume no lagged adjustment. Equation (6) can then be first-differenced to obtain a possible estimating equation:

$$\begin{aligned}\ln\left(E_{ft}\right) - \ln\left(E_{ft-1}\right) = B_{70} + B_{71}\{\left[\left(P_{r\&dft} * X_{r\&dft}\right)/C_{ft}\right] * \ln\left(1 - CREDIT_{ft}\right) \\ - \left[P_{r\&dft-1} * X_{r\&dft-1}/C_{ft}\right] * \ln\left(1 - CREDIT_{ft-1}\right)\} + F_t + e_{7ft} \quad .\end{aligned} \tag{7}$$

Alternatively, we can allow for lagged adjustment. We assume that Equation (6) expressed desired employment $E_{ft}^{*}$ and that actual employment adjusts towards desired employment by only a portion of the gap between the two:

(8) $$\ln E_{ft} = \ln E_{ft-1} + \lambda(\ln E_{ft}^{*} - \ln E_{ft-1}) \quad ,$$

which implies

(9) $$\ln E_{ft} = \lambda \ln E_{ft}^{*} + (1-\lambda)\ln E_{ft-1} \quad .$$

Substitution of (6) (with Equation 6 modified to be true only for desired employment) into (9) then yields another possible estimating equation:

(10) $$\begin{aligned} \ln E_{ft} &= \lambda B_{60} + \lambda B_{61}\left\{\left[\left(P_{r\&dft} * X_{r\&dft}\right)/C_{ft}\right] * \ln\left(1 - CREDIT_{ft}\right)\right\} \\ &\quad + F_f + F_t + \left(1-\lambda\right)\ln E_{ft-1} + e_{10ft} \quad . \end{aligned}$$

In this estimating equation, the coefficient on the tax credit variable is the short-run effect of the tax credit on employment. The long-run effect is equal to that short-run effect divided by (1 minus the coefficient on lagged employment).

As is well known, with a lagged dependent variable, a fixed cross-sectional effect, and a short panel (six years in our case), ordinary least squares estimation of the parameters will be biased. This bias occurs because the estimation cannot distinguish between the effects of the lagged dependent variables and the fixed effect in a short panel, even as the number of cross-sectional observations approaches infinity. This bias is discussed in Nickell (1981).

Solutions to this bias have been developed by Arellano and Bond (1991). The solution is essentially to first-difference Equation (10), in order to get the following equation:

$$
\begin{aligned}
(11)\quad & \ln E_{ft} - \ln E_{ft-1} = B_{110} + \lambda B_{61} \\
& * \left\{ \left[ \frac{\left(P_{r\&dft} * X_{r\&dft}\right)}{C_{ft}} \right] * \ln\left(1 - CREDIT_{ft}\right) - \left[ \frac{\left(P_{r\&dft-1} * X_{r\&dft-1}\right)}{C_{ft-1}} \right] * \ln\left(1 - CREDIT_{ft-1}\right) \right\} \\
& + F_t + (1-\lambda)\left[\ln E_{ft-1} - \ln E_{ft-2}\right] + e_{11ft} \quad .
\end{aligned}
$$

This eliminates the firm fixed effect without having to directly estimate it. However, the first difference in the lagged dependent variable will now be correlated with the disturbance term. The proposed solution is to use further lags in levels of the dependent variable as instruments. As compared to the simple first-differencing that derives from Equation (7), first-differencing this model is more complex and requires further assumptions about how the disturbance terms behave over time for a given firm. Furthermore, because it allows for changes in employment to be due both to current changes in the R&D variable and to lagged changes in R&D from the lagged dependent variable, this approach is likely to yield less precise estimates. However, the lagged dependent variable approach is more appropriate if we are convinced that lags in adjustment are of sizable importance.

One issue is whether the credit rate included in estimating Equation (11) or Equation (7) should be the average R&D credit rate or the marginal credit rate. As argued above, it seems likely that for most firms, the marginal price of R&D for small expansions should be of greater importance.

The key endogeneity problem in estimating Equations (7) or (11) is that the R&D credit variable as specified is clearly endogenous. We are specifying the variable as the natural logarithm of the effect on the R&D price due to the credit weighted by the current R&D factor share. Alternatively, we can view this as specifying the R&D credits paid as a percentage of total costs. The reason for this specification is that it assumes that the coefficient on this combination variable will be the same across firms. But actual R&D spending is clearly endogenous. As the firm expands output and employment, it will also expand R&D. Without correcting for this endogeneity, we would expect the estimated coefficient on the combination R&D variable to be biased towards finding larger effects of R&D credits on employment. (That is, the estimated coefficient on the R&D variable in these equations will be biased in a negative direction.)

To deal with this, we instrument for the R&D variable by predicting the R&D factor share with variables that do not depend upon the firm's decisions, after controlling for firm fixed effects. That is, the instrumental variables (IVs) do not depend upon changes in the firm's decisions over time. The actual R&D credit rate that is part of the R&D variable is assumed to simply be equal to the calculated average or marginal R&D credit rate for that firm in creating this instrumental variable.

We used three different approaches in creating the instrument. Approach (1) recalculates the R&D credit variable by multiplying ln(1 − firm's credit rate) × the factor share for R&D observed in that year for all Washington firms in that industry other than the firm itself. Approach (2) recalculates the R&D credit variable by multiplying ln(1 − firm's credit rate) × the factor share for R&D observed in that year for the entire nation for that industry. Approach (3) takes the firm's actual R&D factor share for the first year it is observed in our sample. It then updates that factor share based on changes over time in the nation for R&D factor shares in that firm's industry. For all of these approaches, since the estimating equation is ultimately first-differenced, the instrumental variables we create are also first-differenced after substituting predicted factor shares for actual firm factor shares to create a predicted R&D credit variable.

Approach (1) controls for firm-specific effects on employment and output that might bias results. However, this approach might be biased if there are Washington State employment trends by industry that are correlated with changes in industry R&D spending, which is certainly possible. Approach (2) avoids the problem of Washington State trends by industry by using national factor shares. However, both Approach (1) and Approach (2) suffer from only having variation in the predicted firm factor share across industry. This limited variation restricts the predictive quality of an instrument. Approach (3) uses firm-specific information for the first year it is observed for R&D factor share. This information does not bias the instrument because our estimating equations implicitly control for firm fixed effects by first-differencing. Using this firm-specific information helps the instrument's predictive ability.

We explore a variety of estimating approaches in our resulting estimation. Even though we have a large panel of firms, we are straining the ability of estimators to detect employment effects because the R&D credit is such a modest cost shifter. Therefore, we must be pragmatic in seeing what restrictions we need to impose to get reasonably precise estimates.

## DATA

Firms that claim the credit are required to file a response to a survey questionnaire as backup documentation. JLARC constructed a data set with these responses covering the years 2004 to 2009 and supplied it to us. In addition to the survey data, JLARC had requested and included in the data set employment and earnings data from the Washington Employment Security Department (ESD) for each of the firms. Table 1 provides descriptive information about the firms in this data set.

In each year of the data, there are about 700 observations. Just under half of the firms are in the Professional, Scientific, and Technical Services sector. The next most populous sector is Manufacturing, which accounts for about 20 percent of the firms. About five-sixths of the firms are headquartered in Washington State. Most of the firms are relatively modest in size. The median level of gross revenue is about $3.0 million, and the median level of (self-reported) employment is about 20. Note that there is a share of much larger firms that causes the averages of these statistics to be much larger. Not surprisingly, these firms undertake a substantial amount of R&D. The median self-reported annual expenditures on R&D ranged between $0.5 and $0.8 million—a sizeable proportion of gross revenue. The average share of the Washington workforce reported to be in R&D is around half.

**Table 1 Descriptive Statistics about Firm, by Year**

| | Year | | | | | |
|---|---|---|---|---|---|---|
| Characteristics | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Industry (NAICS Code) (%) | | | | | | |
| Manufacturing (33) | 18.2 | 18.9 | 18.7 | 18.5 | 18.9 | 18.6 |
| Wholesale Trade (42) | 7.1 | 6.7 | 6.6 | 6.4 | 6.4 | 6.0 |
| Information (51) | 11.8 | 10.5 | 9.8 | 9.6 | 9.6 | 9.3 |
| Prof., Tech., and Scientific (56) | 45.2 | 46.7 | 48.1 | 48.4 | 48.1 | 49.4 |
| All other | 17.7 | 17.2 | 16.8 | 16.1 | 17.0 | 16.7 |
| Location of headquarters (%) | | | | | | |
| Washington | 83.2 | 83.7 | 83.4 | 84.4 | 84.8 | 85.3 |
| All other | 16.8 | 16.3 | 16.6 | 15.6 | 15.2 | 14.7 |
| Gross revenue, median/average ($ million) | 2.1 / $27.7 | 2.7 / 27.5 | 2.9 / 30.7 | 3.1 / 37.5 | 3.3 / 45.6 | 3.2 / 43.2 |
| R&D spending, median/average ($ million) | 0.5 / 11.4 | 0.8 / 10.2 | 0.7 / 11.7 | 0.8 / 12.6 | 0.8 / 14.2 | 0.6 / 13.4 |
| High-tech credit, median/average ($ thousand) | 5.3 / 39.6 | 4.4 / 31.0 | 4.3 / 34.2 | 5.3 / 37.5 | 5.5 / 43.6 | 6.0 / 46.7 |
| Employment | | | | | | |
| In Washington, median/average | 16 / 186 | 20 / 225 | 20 / 252 | 20 / 270 | 21 / 295 | 19 / 286 |
| Percent full time, average | 83.3 | 88.3 | 87.4 | 86.6 | 86.8 | 85.6 |
| Percent in R&D, average | 40.2 | 53.5 | 51.1 | 51.4 | 50.3 | 51.3 |
| Worldwide, median /average | 17 / 714 | 21 / 826 | 24 / 879 | 25 / 1,231 | 25 / 1,035 | 22 / 1,119 |
| Sample size | 736 | 715 | 722 | 738 | 718 | 699 |

SOURCE: Tabulation of Washington Tax Incentive Survey.

Questions on the survey ask firms to report “the amount of credit claimed for the calendar year” and to answer the question “How many new employment positions did your firm create in Washington State during the calendar year?” Table 2 summarizes these survey data by year. Note that these data are again somewhat skewed by the larger firms in the population of firms.

**Table 2 Self-Reported Employment Creation and Tax Credit, by Year**

| Year | Average employment created (Question 10) | Total employment created | Average credit (Question 1a) | Total credits taken ($ million) |
|---|---|---|---|---|
| 2004 | 5.39 | 3,223 | $39,611 | $23.687 |
| 2005 | 31.07 | 16,622 | 31,003 | 16.587 |
| 2006 | 27.49 | 13,937 | 34,229 | 17.354 |
| 2007 | 27.05 | 14,309 | 37,499 | 19.837 |
| 2008 | 33.17 | 16,885 | 43,599 | 22.192 |
| 2009 | 18.25 | 9,305 | 46,696 | 23.815 |
| All years | 23.30 | 74,281 | 38,730 | $123.472 |

SOURCE: Washington Tax Incentive Survey.

## Data Exclusions

Table 3 presents the number of firms in the survey data and used in the estimation of the models. A total of just under 1,000 unique firms claimed the credit during at least one of the analysis years (2004–2009). As noted in the table, the annual number of firms claiming the credit ranged between 507 and 574 during those years. The entries in the second and third columns in that table come from Department of Revenue (DOR) tax-return data that were appended to the database. They show the average credit taken and the total credit taken, by year. The average credit taken by firms during this period is just under $40,000. The total credit taken, by year, is quite similar to the data presented in Table 2, indicating that the self-reported credit data on the survey were reasonably accurate.

**Table 3 Number of Firms and Credits Taken, by Year**

| Year | Number of firms with credit | Average credit ($) | Total credit ($ million) | Number of firms after data editing |
|---|---|---|---|---|
| 2004 | 574 | 41,521 | 23.833 | 413 |
| 2005 | 548 | 33,834 | 18.541 | 447 |
| 2006 | 516 | 33,674 | 17.376 | 430 |
| 2007 | 528 | 36,908 | 19.487 | 445 |
| 2008 | 511 | 44,367 | 22.672 | 439 |
| 2009 | 507 | 48,010 | 24.341 | 412 |
| Total (unduplicated) | 991 | 39,651 | 126.250 | 672 |

SOURCE: Tabulations of Department of Revenue (DOR) data.

To estimate the models, several data editing steps were taken that resulted in observations being deleted from the data. The final column of Table 3 shows the number of firms that were left after data editing. This column provides the sample sizes used in estimating the models. The deletions that were made include omitting NAICS codes 112 (Animal Production) and 921 (Public Administration—Executive, Legislative, and Other Government Support) because we had no national R&D data for these industries to use in the construction of the IVs. This deleted two firms. We also deleted firms in which there was a single year of data because the models described above included lagged dependent variables. This deleted 167 firms. We deleted observations in which the credit and the value of R&D spending were 0 or missing. This further reduced the number of firms by 19. Finally, we deleted observations that were missing the administrative-sourced employment or earnings data from the ESD. This deleted 131 additional firms. The total number of firms in the remaining analysis sample was 672, ranging between 412 and 447 each year.

## RESULTS

We estimated the levels model, Equation (10), and the growth model, Equation (7), for three dependent variables (employment, earnings, earnings/worker) with all three IVs. Table 4 shows the estimation results for the levels and for the growth models for employment and earnings for the three sets of IVs using the marginal credit ratio. The entries in the table are the $B_{61}$ and $B_{71}$ parameter estimates and their standard errors. Our preferred specification is to use the growth model and the IV that is presented in the third column—i.e., using a baseline R&D factor share and inflating it annually at the rate of growth of R&D in the industry. Not only are the results in agreement with our hypothesized sign and level, but also, the IV is estimated with precision in the first-stage regression.[1]

**Table 4 Parameter Estimates**

| Dependent variable/model | Industry average (w/o firm) | Instrumental variable national R&D factor-share growth rate | Baseline factor share growing at national rate |
|---|---|---|---|
| Employment/ levels | −2.89 | −0.26 | −6.98 |
| | (6.21) | (5.36) | (4.27) |
| Employment/growth | −10.44 | −2.02 | −4.94*** |
| | (8.06) | (6.32) | (1.92) |
| Earnings/ levels | 15.20*** | 13.97*** | 4.77 |
| | (6.56) | (5.90) | (3.89) |
| Earnings/growth | −13.14 | −2.64 | −2.90 |
| | (10.68) | (8.21) | (2.42) |

NOTE: Entries are the estimates of the parameters $\lambda B_{61}$ from Equation (10) for the levels model and $B_{71}$ from Equation (7) for the growth model. Robust standard errors are presented in parentheses.
*** significant at the 0.01 level.

The parameter estimates do not easily translate into employment growth. To estimate the job growth that resulted from the tax credit, we have used the firms' data and used the parameters from our (preferred) estimated model with the actual marginal credit ratio and with a marginal credit rate of 0 (assuming that the credit did not exist) to predict employment growth with and without the credit.[2] We did a similar calculation for total wages at the firm. Table 5 presents these results.

[1] Equation (10), containing the levels model, was estimated by the Generalized Method of Moments (GMM) with the Stata routine xtdpd. The Sargan test of overidentifying restrictions had $\chi^2(9)$ levels of 9.2, 7.7, and 8.2 for the three employment equations. These levels were not sufficient to reject the null hypothesis of valid restrictions. On the other hand, the $\chi^2(9)$ levels for the earnings equations were 22.2, 20.5, and 25.6 for the earnings equations. All of these levels were sufficient to reject the null hypothesis of valid overidentifying restrictions. Equation (7), containing the growth models, was estimated by two-stage generalized least squares using the Stata routine xtivreg, which is suitable for panel data. The first-stage coefficient estimates and robust standard errors for the employment equations were 0.169 (0.047), 2.791 (0.718), and 0.402 (0.029), all significant at the 0.01 level. The first-stage coefficient estimates and robust standard errors for the earnings equations were 0.166 (0.051), 2.817 (0.764), and 0.401 (0.031), all significant at the 0.01 level.

[2] Note that many firms' marginal credit ratio is 0, so no simulated job creation occurs at these firms.

**Table 5 Estimated Employment and Earnings Creation, by Year**

| Year | Employment | Earnings ($ million) | Total credit taken ($ million) |
|---|---|---|---|
| 2005 | 378<br>(84, 672) | 14.244<br>(−9.528, 38.016) | 18.541 |
| 2006 | 430<br>(96, 764) | 18.988<br>(−12.702, 50.678) | 17.376 |
| 2007 | 469<br>(117, 833) | 21.114<br>(−14.125, 56.353) | 19.487 |
| 2008 | 511<br>(114, 907) | 23.019<br>(−15.399, 61.437) | 22.672 |
| 2009 | 484<br>(108, 860) | 20.728<br>(−13.866, 55.322) | 24.341 |

**NOTE**: Table entries in the second and third column are estimated employment and earnings created as a result of the R&D tax credit. The entries in parentheses are the lower and upper bounds of a 95 percent confidence interval. All entries have been adjusted upward by a factor to take into account that the simulations of the growth model could only be done when data existed for consecutive years. The adjustment factors for employment, by year, were 1.1310, 1.1583, 1.1162, 1.0771, and 1.0705. The adjustment factors for earnings were 1.1307, 1.1554, 1.1154, 1.0755, and 1.0702. In other words, these factors ranged from about 7 to about 16 percent. The "Total credit taken" data are from Department of Revenue (DOR) data.

As seen in the table, the number of jobs created by the tax credit annually ranged between about 380 and about 510. These represented a growth in jobs at these firms of between 0.53 and 0.62 percent.[3] The amount of earnings generated in the state from these jobs ranges from about $14.2 million to $23.0 million. These levels of earnings represented a growth in earnings of 0.62 percent. The amount of earnings generated in the state from these jobs ranges between 0.20 and 0.25 percent.[4] The average cost per job created, calculated by dividing the entries in the last column of Table 5 by the jobs created in the second column, ranges from $40,409 (2006) to $50,291 (2009).

The employment creation numbers reported in Table 5 are "job-years" created. They should not be interpreted as existing permanent jobs created each year. Our model estimates that

[3] Calculations based on average firm size: 202, 211, 199, 219, and 226 in 2004 through 2008, respectively.

[4] The fact that wages increased less than employment suggests that the credit had a negative impact on wages per employee. That is precisely what our estimates show when the ratio of wages to employment is used as the dependent variable. This finding is not surprising, because one would assume that new hires make, on average, less than incumbent workers. In addition, the tax credit may have a higher-percentage effect on costs in lower-wage firms.

a change in the tax credit causes a once-and-for-all permanent change in the number of jobs in the state. Therefore, the job-years listed in the second column should not be summed to get a cumulative total of jobs created. A negative interpretation of the results may be easier to understand:  if policymakers had eliminated the tax credit in 2009, the state would have had a level of jobs in these firms that would have been permanently lower by 484 jobs.

**Sensitivity Analyses**

We conducted three types of sensitivity analyses to get a sense of the robustness of our estimates. First, in the above table, we considered the confidence intervals for our results, based on the statistical confidence intervals around our point estimates. For example, for 2009 the confidence interval for jobs created spans from 108 jobs to 860 jobs. With a tax credit cost of $24.34 million, this implies a cost per job created that spans from $225,000 ($24.34 million divided by 108) to $28,000 ($24.34 million divided by 860).

Second, we used the coefficient from the first column in Table 4 that used industry-average R&D factor shares as instrumental variables. Note that this coefficient is more than twice as large as our preferred specification (−10.44, compared to −4.94), implying that firms are much more responsive in their hiring decisions to the "cost" of R&D than the responsiveness implied by the preferred specification. The permanent employment gain was correspondingly about twice as large—in 2009, the simulated number of jobs created was 1,023, as compared to 484. This represents an employment growth at the firms taking the credits of approximately 1.2 percent. With more jobs created, the cost per job decreases. Specifically, the cost per job created was $23,800. Similarly, we used the coefficient from the first column of Table 3 to calculate the additional wages. The coefficient was about four times larger, and, concomitantly, the increase in total wages was about four times larger: in 2009, the simulated increase in wages paid was $93.89 million, compared to $20.73 million.

As noted above, the marginal tax credit ratio is 0 for firms whose credits have been capped at $2 million and for firms whose credit is equal to or exceeds their tax liability (the credit is nonrefundable), so the simulated job gains are 0 for those firms.[5] Consequently, we did a third sensitivity analysis in which we used the average credit ratio to calculate job gains, rather than the marginal credit ratio. This assumption was combined with the −4.94 coefficient estimated in the table using the marginal tax credit variable. The number of jobs created in 2009 because of the tax credit was 623 in this analysis, and the average cost per job created was $39,069.[6]

## DISCUSSION

### Export-Based Industries

Arguably, output and employment growth in an export-based industry[7] has more positive implications for the economic growth of a state than does growth in a non-export-based industry. For export-based industries, we might expect multiplier effects of employment expansions on other industries, due to supplier links or respending of the export-based industry workers' wages

[5] The $2,000,000 cap affected only two firms in our data—a total of seven observations in our six-year panel of data. On the other hand, almost 30 percent of the firms in our analysis file (198 out of 672) had marginal tax rates of 0 because the credit equaled their entire tax liability.

[6] For the majority of observations in our data, the marginal credit ratio and the average credit ratio are the same. The exceptions to this are the firms for which the credit was capped. For those firms, this sensitivity analysis suggests that the firms respond to their average credit ratio. So the difference in results is solely due to those firms.

[7] For this discussion, an "export" is defined as a sale that crosses state lines. It could be to an international buyer or to a domestic buyer in another state. Thus, Washington State's "export base" includes goods and services sold to residents and businesses in such "foreign" places as Oregon. It is these export-based sales that bring new dollars into a state's economy.

at local retailers. Such multipliers could quite plausibly be in the 1.5 to 2.0 range—that is, from 0.5 to 1.0 additional spin-off jobs for every 1 additional export-based industry job. More precise multipliers require a regional econometric model for the state of Washington that would incorporate state-specific supplier links and wage-rate data.

In contrast, it is unclear whether encouraging employment growth in non-export-based firms will have any net positive effects on state employment. Non-export-based firms provide output based on local demand. If such firms expand in response to some tax policy, this reduces potential sales for other firms in that same industry. As a result, net industry employment may not increase; the subsidy may merely redistribute sales in the industry. (The non-export-based firms may also have supplier links within the state economy, but if the magnitude of sales within a state to these non-export-based firms as a group is determined by the size of the state's economy, any redistribution of employment and sales among non-export-based firms will merely redistribute activity among their suppliers as well.)

Using earlier analysis by one of the authors (Bartik, Erickcek, and Huang 2007) that identified export-based and non-export-based sectors using location quotients, we calculated the employment gain for these two types of firms. Whereas about 75 percent of the employment in the sample of firms claiming a credit was in export-based industries (58,600 out of 80,600), only about 40 percent of the employment creation occurred in those industries. If there were a multiplier of 2.0 for the export-based firms, and 0.0 for the non-export-based firms, the net employment creation would be approximately 80 percent as large as the figures presented in Table 5.

## Opportunity Cost of Public Funds

With a balanced state budget, the funds used to pay for the R&D tax credit have to come from somewhere. Plausible sources are some reduction in public spending or some increase in other taxes. This reduction in public spending or increase in other taxes would have a negative impact on demand for goods and services in the state economy. These negative impacts would be offset to some degree by the demand-side impact of the use of the R&D tax credit by business owners. Depending upon what public services were altered, or what taxes were altered, there might also be some negative impacts from affecting the supply of labor or capital or other factors of production. The economic impact of such changes in public spending or taxes would be best measured with a Washington State–specific econometric model of the state economy.

However, we can estimate plausible magnitudes of these changes in other public spending and taxes by using results from previous studies of regional economies. For example, Bartik and Erickcek (2004) estimate that a state public spending cut that finances an equal-sized state tax cut will have balanced-budget effects on job creation in which each $138,045 in state public-spending cuts will result in the net loss of one job. In the case of the high-tech tax credit incentive, the $24.341 million of resources devoted to the R&D tax credit in 2009, if financed by a cut in public spending, would result in a loss of 176 jobs. This would offset a portion, but by no means all, of the positive effects of our 2009 estimate in Table 5 that the tax credit creates 484 jobs.

## Fiscal Benefits

The net jobs created by the R&D tax credit would result in fiscal benefits and costs. The job creation generates income and wealth that will result in a larger tax base for state and local governments. On the other hand, the job creation will also result in additional population, which will require additional public spending to avoid service deterioration. On net, we expect the fiscal benefits to exceed costs.

Estimating fiscal benefits and costs requires a fiscal impact model specific to the state and local tax system in Washington, along with an econometric model of how population will adjust to the job creation. Rough magnitudes of possible fiscal benefit offsets can be gauged from previous studies of state economies. Bartik and Erickcek (2010) conclude that each new job created by a state tax-credit program in Michigan produced about $3,100 (in 2009 dollars) in fiscal benefits to partially offset the costs of the program. If a similar number applied in the state of Washington, the 484 jobs that are estimated to be created in 2009 because of the tax credit would provide about $1.5 million in fiscal benefits. This would offset less than 10 percent of the $24.34 million cost of the credit.

## CONCLUSION

Our analyses of tax credit data suggest that the high tech R&D tax credit does increase employment to a very modest extent. The analyses suggest that employment grew by between 0.5 and 0.6 percent at the firms that claimed credits because of the tax credit; however, our sensitivity analysis suggests that the rate may be as high as twice that if firms are as responsive to their R&D costs as our largest estimated response suggests. The specification that seemed to work best empirically suggests that firms respond to the marginal credit rate—which, it should be noted, is zero for slightly less than one-quarter of the sample.

The cost per job created implied by these estimates is relatively high. The range in the above estimates is from just over $40,000 to just over $50,000 per job created. Although the jobs created may pay more than those figures, not all earnings generated are a pure benefit. We know from previous studies that only a portion of newly created jobs actually result in increased local employment rates and earnings per capita. In general, up to four-fifths of all new jobs in a state will end up being reflected in higher population rather than higher state employment rates. That is, a 1 percent increase in a state's employment is estimated to lead after five or more years to a 0.8 percent increase in state population, with a resulting increase of 0.2 percent in the state's employment-to-population ratio (Bartik 1991, 1993). Some of the new jobs will also lead to the state's residents being able to move up to better-paying jobs than would have occurred otherwise, as the new jobs make it easier for state residents to be hired in better-paying occupations. Estimates suggest that a 1 percent increase in a state's employment leads to a 0.2 percent increase in earnings per capita because of state residents moving up to better-paying occupations (Bartik 1991).

Combining these two effects, a 1 percent increase in jobs, which would directly increase state earnings by 1 percent if the jobs pay similarly to the average state job, will actually lead to a somewhat lower 0.4 percent increase in state earnings per capita:  0.2 percent from higher state employment rates, and 0.2 percent from state residents moving up to better-paying occupations. The boost in state earnings of 0.4 percent is 40 percent of the 1 percent extra earnings directly associated with the new jobs. Therefore, in evaluating the benefits for state residents from new jobs, we should not assume that 100 percent of the earnings from the new jobs lead to higher earnings for the original state residents. Only about 40 percent of the earnings from the new jobs are likely to do so.

Why is this study's cost per job created so high? Four reasons seem most important. First, this study finds, consistent with the research literature on business tax effects and wage effects on local business activity, that state and local business activity is only modestly responsive to subsidies that lower costs. Second, for the firms receiving this particular tax credit, the ratio of earnings and output to employment is relatively high, which implies that a given amount of dollars in tax credit has more modest percentage effects in lowering overall business costs. Third, a significant proportion of the tax credits are capped, which means that on the margin these tax credits do not lower the costs of expanding Washington employment. Fourth, a significant proportion of the tax credits are awarded to non-export-based firms, which will have lower effects on overall Washington employment.

These explanations point to ways to lower the cost per job created from this policy. In particular, targeting export-based firms with high multiplier effects, and making sure that incentives affect the marginal costs to firms of expanding, will help reduce the cost per job created. Higher multiplier effects will be more likely if firms have stronger local supplier links. Finally, if the goal is job creation, directly tying the magnitude of the incentive to job creation provides a greater reason for firms to respond to the incentive with job creation.

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