Review of Recent Evaluations of R&D Tax Credits in the UK

Mike King

(Seconded from NPL to BEIS)

Introduction

This presentation reviews three recent UK-based studies estimating the effect of R&D tax credits on recipients' R&D spending.

- HMRC (2015) 'Evaluation of Research and Development Tax Credit'

- Guceri, I.; Liu, L. (2015) 'Effectiveness of Fiscal Incentives for R&D: Quasi-Experimental Evidence'

- Dechezlepretre, A.; Einio, E.; Martin, R.; Nguyen, K.T; Van Reenen, J. (2015) 'Do Tax credits for Research Increase Firm Innovation? An RD Design for R&D'

Part 1
Evaluation of Research and Development Tax Credit

Theoretical framework

- An analogy between investment in physical capital and knowledge capital within the optimal capital accumulation framework.

- Used the Hall-Jorgenson formula (B-index) for tax adjusted user-cost of capital. (In equilibrium, investors are indifferent between purchasing an extra unit of capital and earning interest on the money saved.)

- Started by specifying a demand function for R&D investments. It is assumed that R&D spending depends on:

  - Adjustment costs associated with R&D activity (e.g. inertia).
  - The tax adjusted user-cost of R&D is given by $C = B \times (r + \delta)$, where: 'B' depends on the rate of tax relief; 'r' is the interest rate; and 'δ' is the depreciation rate.
  - Firm specific heterogeneity that is stable over time (fixed effect).

Variation in Tax Adjusted User-Cost of Capital

- Costs are deducted from income to determine taxable profits. R&D tax credits allow spending on R&D to be multiplied by a scale-up factor to give 'superdeductions'.

- Payable credits for non-profit making SMEs, as well as, tax deductions for profitable firms. (But the subsidy rate for payable credits is lower.)

- The SME scheme has always been more generous than the Large Company scheme. And, the 'mid-size extension' of 2008 reclassified some large firms as SMEs.

- Finally, not all firms have financial years starting on 5th April. And, the generosity of tax credits differs across calendar years.

Methodology

- Conventional to account for the influence of unobservable fixed-effects via the with-in estimator.

- But sources of bias remain:
  - Since R&D spending brings down taxable profits, user-cost is endogenous to the level of R&D spending. This simultaneity means that regressing R&D on user-cost would bias the coefficient on user-cost towards zero.
  - Including lagged R&D spending in the model means that the regressors are no longer strictly exogenous. And, thus, estimates suffer from a type of attenuation bias (Nickell bias).

- Following Bloom et al (2002) the study used the Arellano Bond estimator to overcome these issues.

Arellano Bond

- Taking first differences of the regression model eliminates the fixed effects: $\Delta R_t = \beta_0 + \beta_1.\Delta R_{t-1} + \beta_2.\Delta C_t + \Delta u_t$, where we would expect $\beta_2 < 0$.

- The lagged first difference of R&D spending (ΔR_{t-1}) remains endogenous but consistent estimates can be found using deeper lags of R_t as instruments (R_{t-3}, R_{t-4}, ...).

- The exogeneity conditions for these instruments generate a series of moment conditions: $E(R_{t-s} \times \Delta u_t) = 0$ for $t \geq 3$, $s \geq 2$. These are valid providing there's no serial correlation in the errors (u_t).

- These moment conditions enable the model to be estimated by GMM.

The Dataset (same for other two studies)

- Link tax data from HMTC's CT600 database to financial data from FAME.

- 10 years of data (2003 to 2012) with about 16 thousand firm-years across around 4,700 firms.

- A firm's user-cost of capital depends on whether it claimed under the Large Company scheme or the SME scheme.

- To feature in the estimation, a firm must claim R&D tax credits continuously for at least three years. Thus, the analysis tends to exclude firms with intermittent R&D spending.

Results

- Passes specification tests:
  - Strong evidence of negative first order auto-correlation in the first differenced errors (Δu); which is consistent with zero serial correlation in the errors (u).
  - Sargan test did not reject the validity of overidentifying restrictions (testable exogeneity conditions) that come from having multiple instruments for one endogenous variable.
- The elasticity of R&D spending with respect to tax adjusted user-cost is around -1.96.
- For the LC scheme, £2.35 of extra R&D spending is generated for every £1.00 of tax revenue foregone. (But the additionality ratio of the SME scheme is lower.)

Part 2
Effectiveness of Fiscal Incentives for R&D: Quasi-Experimental Evidence

Policy Change as Basis for Quasi-Experiment

- During the period from 2002 to 2011, SMEs were eligible for a much more generous deduction rate than large firms. For every £100 of R&D, an SME deducts £175 from taxable income rather than £130 in the case of an LC.

- Below a certain size threshold a company is classified as an SME. In 2008, the threshold was doubled so that firms with between 250 and 500 employees were reclassified as SMEs.

Exogenous Sources of Variation

- The newly-qualified SMEs were entitled to more generous deductions compared to large firms. Hence, the cost of capital for the newly-qualified SMEs decreased relative to that of large firms.

- On average, companies in the treatment group (newly qualified SMEs) experienced a reduction in user cost of 21% between 2007 and 2009 if paying the small profits rate.

- For large firms there was a small increases in the rate of R&D tax relief in 2008. However, this was accompanied by a drop in CT rates, which largely offset the benefit from enhanced tax relief. Thus, large firms experienced a negligible reduction in user-cost.

Methodology

- Combined a difference-in-differences approach with a model that includes fixed-effects.

- Used a Poisson Pseudo-Maximum-Likelihood (PPML) estimator. (Avoids the bias the comes from estimating a log-linear model by OLS.)

- For a large company to be in the control group it must have applied for R&D tax credits in at least one year before 2008 and also in at least one year after 2008.

- A company is 'treated' if it carried out R&D before and after 2008 and was **large before 2008** but an **SME after 2008**. This treated group is referred to as 'medium sized' companies.

- The study had 185 firms in the treated group and 1,100 firms in the control group.

Robustness Tests

- Examined the plausibility of the parallel trends assumption.

- Investigated potential anticipation of policy changes:
    - Remove firm-years for 2007-08.
    - Excluded companies created by (or subject to) a merger.
    - Excluded companies with employment between 240 and 260.

- Relabelling of ordinary investment was examined by looking at whether there was any systematic changes to capital investment.

- Combined DiD with matching to achieve a control group that is similar to the treated group. (Similar in terms of characteristics that don't determine eligibility to treatment.)

- Run regressions with placebo policy interventions for each of the pre-reform years. Authors do not find significant effects for any of the placebo reforms.

Results

Effect on newly qualified SMEs:

- On average firms in the treated group increased their R&D investment by around 40% in response to about a 17% increase in the generosity of tax incentives.

- The elasticity of R&D with respect to user-cost is around -2.34.

- For each £1.00 of tax revenue foregone by the Exchequer, R&D spending increases by about £1.60 for a company paying the 'small profits' rate of 21%. And, R&D spending increases by £1.20 for a company paying what was then the main CT rate of 28%.

Part 3
Do Tax credits for Research Increase Firm Innovation? An RD Design for R&D.

Problems with Other Approaches

- Country level macroeconomic studies have the problem that changes of policy often occur at the same time as other events (e.g. recessions) that influence R&D spending. Hence, a probable simultaneity bias.

- Firm level studies have the problem that tax rules are much the same for all firms and the variation that does exist depends on the firms' endogenous behaviour.

- Data limitations and the concentration of R&D means that estimates will be driven by the response of very large firms. And, extrapolating from the response of large firms may be misleading.

Exploit the 2008 Mid-Size Extension

- The UK raised the threshold at which firms can access the more generous tax credits of the SME scheme.

- As this new threshold was unique to the R&D policy, it can be used implement an RD Design study.

- The effect of increasing the subsidy rate on firms near the threshold can be estimated by looking at differences in R&D spending around the new SME threshold.

- Firms are classified as being effected by the policy change on the basis of their size before the policy change.

Robustness Tests

Prior to the policy change:

- Firms either side of the threshold look very similar (covariates balance).

- There was no bunching of the running variable (assets) around the threshold. That is, there is no evidence of firms anticipating the policy and manipulating their size to access more generous subsidies.

- No discontinuity in the level of R&D spending either side of the threshold.

Results

- A large and statically significant effects on R&D spending:
  - R&D spending doubled in the treated firms.
  - The elasticity of R&D with respect to the tax adjusted user-cost was found to be around 2.6, which is higher than typical figures from the literature.
  - Extrapolation to the wider population of users suggests that the scheme induces £1.70 of private R&D for every £1.00 of revenue foregone.
  - Aggregate R&D spending between 2006 and 2011 would have been around 10% lower without R&D tax credits.

- Some (weaker) evidence of effects on innovation:
  - Patenting rose by around 60%
  - The policy may have generated spillovers in the form of more innovation by technologically related firms.