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International Tax Policy Forum

Taxation of Innovation in a Global Economy

American Enterprise Institute
Wohlstetter Conference Center
1150 Seventeenth Street, N.W.
Washington, D.C. 20036

January 20, 2012

International Tax Policy Forum Conference

Taxation of Innovation in a Global Economy

American Enterprise Institute
Friday, January 20, 2012, 8:45 a.m. –12:30 p.m.
Wohlstetter Conference Center, Twelfth Floor, AEI
1150 Seventeenth Street, N.W., Washington, D.C. 20036

Table of Contents

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In today's global economy where countries compete for corporations' research activities, US tax policy lags behind many other developed countries in attracting firms' R&D centers, a key source of jobs and economic growth. The OECD's Science and Technology Scoreboard ranked US tax incentives per dollar of R&D as 24th lowest out of 38 countries. Recognizing the economic importance of the innovation R&D fosters, six EU member countries have adopted reduced tax rates for income derived from patents and certain other intellectual property in the last decade. And, the UK government recently released details of a 10 percent rate on income derived from new innovations that is scheduled to take effect in 2013.

With the increased mobility of research activities and intellectual property, this conference focuses on how countries should tax innovative activities, answering important questions for countries that seek to promote economic growth through innovation.

8:45 a.m.	Registration	
8:50	*Opening Remarks:*	JOHN SAMUELS, General Electric KEVIN HASSETT, AEI
9:00		**Panel I: Innovation Tax Policy around the World**
	Presenters:	JAMES SHANAHAN, PricewaterhouseCoopers KEN GAO, PricewaterhouseCoopers
	Moderator:	MICHAEL GRAETZ, Columbia Law School
10:00		**Panel II: How Effective are Tax Incentives at Encouraging R&D?**
	Presenter:	NIRUPAMA RAO, New York University
	Discussant:	ROSANNE ALTSHULER, Rutgers
	Moderator:	MIHIR DESAI, Harvard Business School
10:45	Break	
11:00		**Panel III: Corporate Tax Policy and the Location of Innovative Activity**
	Presenters:	RACHEL GRIFFITH, University of Manchester HELEN MILLER, Institute for Fiscal Studies
	Discussant:	C. FRITZ FOLEY, Harvard Business School
	Moderator:	MATTHEW SLAUGHTER, Dartmouth
11:45		**Panel IV: How Should the United States Tax the Returns to Innovation?**
	Panelists:	ALAN AUERBACH, University of California, Berkeley MICHAEL GRAETZ, Columbia Law School PAUL OOSTERHUIS, Skadden Arps STEPHEN SHAY, Harvard Law School
	Moderator:	JAMES HINES, University of Michigan
12:30 p.m.	Adjournment	

Register for this conference on-line at:
http://www.aei.org/events/2012/01/20/taxing-innovation-in-a-global-economy/

www.pwc.com

Innovation Tax Policy around the World

James Shanahan
Leader, Global R&D Incentives Group

January 20, 2012

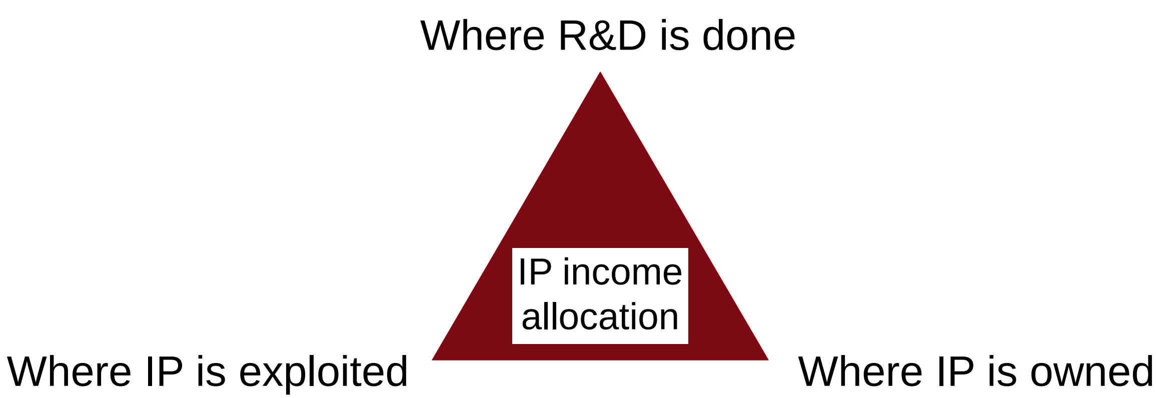
pwc

Agenda

- The Innovation Value Chain
- Why Governments Provide Tax Incentives for R&D
- International Comparison of R&D Tax Incentives
- International Comparison of Reduced Tax Rates for Innovation Income (“Innovation Box”)

The Innovation Value Chain

1. **Research** - The creation of technological IP often involves intensive research activity, with substantial up-front cost with an uncertain future reward.
2. **Development** - Turning an initial patent or concept into a marketable product requires a range of complementary activities, including further R&D activity either on the IP itself or processes required to manufacture or deliver product or service.
3. **Commercialization** - Successful exploitation in the global market requires significant further high value activity.



Why Governments Provide Tax Incentives for R&D

Competitiveness Issues

- Economic studies indicate that a high proportion of economic growth is attributable to technological change.
- R&D activities are increasingly mobile.
- R&D location decisions may be based not only on R&D incentives but also on tax rate imposed on IP income.
- To provide an attractive location for R&D, countries must consider R&D tax incentives as well as income tax rates in other jurisdictions.

Why Governments Provide Tax Incentives for R&D

Competitiveness Issues

"The location of R&D activity can matter. For example, technological prowess may help a country reap the financial and employment benefits of leadership in a strategic industry. A cutting-edge scientific or technological center can create a variety of spillovers that promote innovation, quality, skills acquisition, and productivity in industries located nearby; such spillovers are the reason that high-tech firms often locate in clusters or near leading universities. To the extent that countries gain from leadership in technologically vibrant industries or from local spillovers arising from inventive activity, the case for government support of R&D within a given country is stronger."

- Ben Bernanke, "The Governments Role in Promoting R&D," May 16, 2011

International Comparison of R&D Tax Incentives

Menu of Possible Tax Incentives for R&D Activities

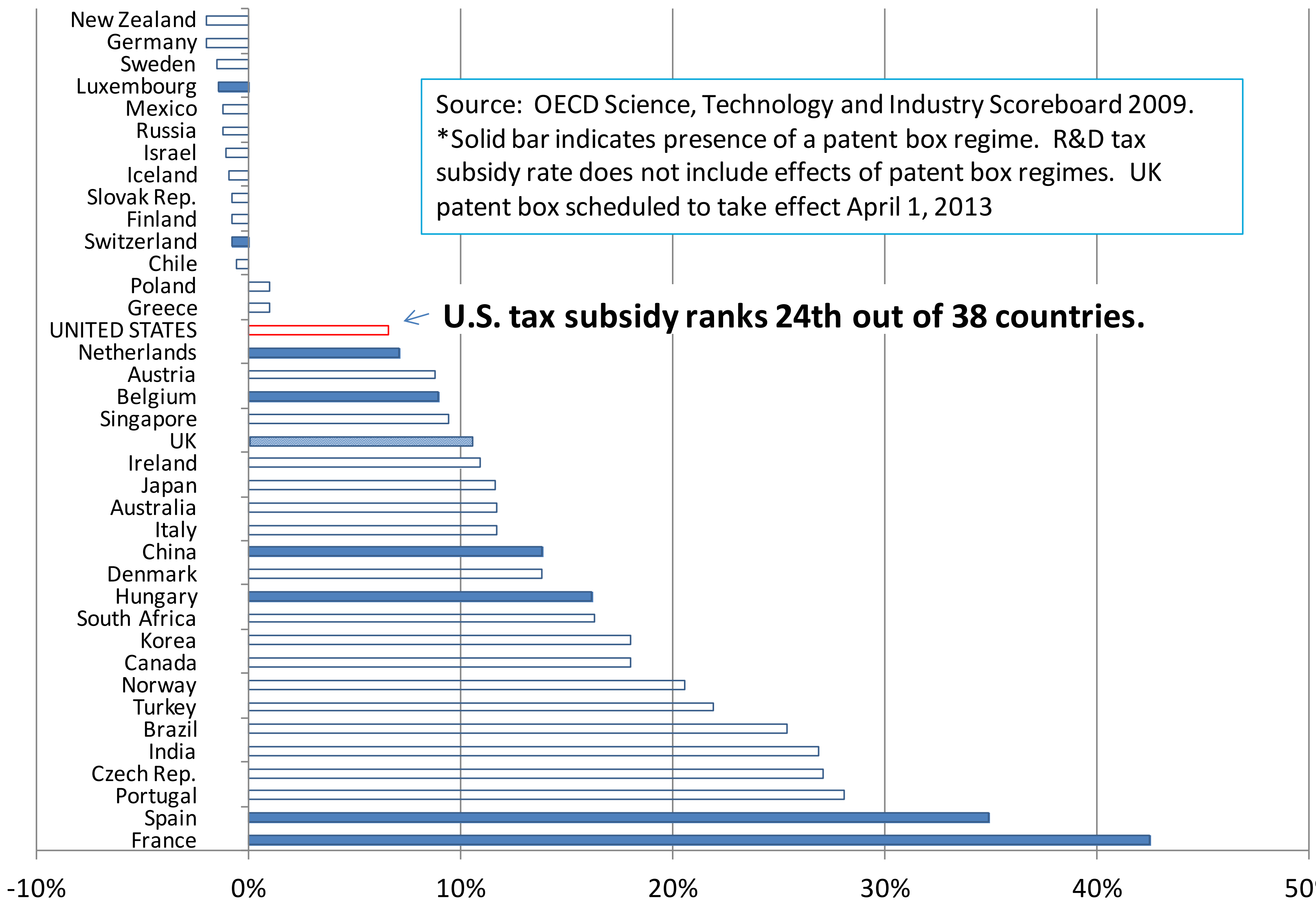
Front-end incentives

- Credit for R&D expenses
- Deduction of more than 100% for R&D expenses (“super” deduction)

Back-end incentives

- Lower tax rate for income derived from intellectual property (“innovation box”)

Tax Subsidy Rate for R&D in OECD and 7 Other Countries, 2008*



International Comparison of R&D Tax Incentives

Front-End Incentives: Design Issues

1. Qualifying R&D activities v. “discovery”
2. Location of qualifying R&D activities and location of IP
3. Tax credit v. “super” deduction

International Comparison of R&D Tax Incentives

Qualifying R&D Activities v. "Discovery"

- "Research" v. "Development"
- Revolutionary v. Evolutionary
- OECD (Frascati) definition
- U.S. definition

International Comparison of R&D Tax Incentives

Location of Qualifying R&D Activities and Location of IP

Qualifying R&D Activities Must Occur Within Country
Australia
Brazil
Canada
China
India
South Africa
United States

Resulting IP Must Be Retained in Country
China
Japan

International Comparison of R&D Tax Incentives

Tax Credit v. "Super" Deduction

Select "Tax Credit" Countries	Volume based?	Refundable?
Australia	Yes	Yes
Canada	Yes	Yes
France	Yes	Yes
Ireland	Yes	Yes
Italy	Yes	
Japan	Yes	No
Spain	Yes	No
United States	No	No

International Comparison of R&D Tax Incentives

Tax Credit v. "Super" Deduction

Select "Super Deduction " Countries	
Brazil	160%
China	150%
Czech Republic	200%
Hungary	200%
India	200%
The Netherlands	140%
Russia	150%
South Africa	150%
Turkey	200%
United Kingdom	130% (Refundable – April 2013)

International Comparison of R&D Tax Incentives

Tax Credit v. "Super" Deduction

Select Countries with No R&D Tax Incentives
Finland
Germany
Israel
Mexico
New Zealand
Sweden

International Comparison of "Innovation Boxes"

Issues in the Design of an "Innovation Box" Regime

A. Qualifying IP
   1. Patents
   2. Other IP, e.g., copyright, trademark, formula, process, design, pattern, knowhow, trade secret?
   3. Self-developed, licensed-in, and acquired IP?
   4. New and existing IP? Improvements to existing IP?
   5. IP development required to be performed in country?

B. IP Income in "Box"
   1. Gross or net qualifying IP income?
   2. IP embedded in price of goods and services?
      - Formulary or transfer pricing approach?
   3. Limited to income from domestic exploitation of qualified IP?

C. Treatment of Income in "Box"
   1. Deduction or partial exclusion?
   2. Cap on tax benefit?
   3. Credit for withholding taxes on IP income?

D. Coordination with Existing R&D Incentives

EU Patent Box Regimes, and UK Proposal

Source: PwC. Information current as of December 31, 2011.

	Effective tax rate	Qualified IP	Qualified income
Belg.	Maximum 6.8%	Patents and extended patent certificates	Patent income less cost of acquired IP
France	Maximum 15%	Patents, extended patent certificate, patentable inventions, industrial fabrication processes	Royalties net of cost of managing qualified IP.
Hungary	Maximum 9.5%	Patents, know-how, trade marks, business names, business secrets, and copyrights	Royalties
Lux.	Maximum 5.76%	Patents, trademarks, designs, domain names, models, and software copyrights	Royalties.
Neth.	5.00%	Patented IP or R&D IP	Net income from qualified IP.
Spain	Maximum 15%	Patents, secret formulas, processes, plans, models, designs, and know-how	Gross patent income
UK	10%	Patents, supplementary protection certificates, regulatory data protection and plant variety rights	Net income from qualifying IP

	Acquired IP?	Cap on benefit?	Includes embedded royalties?	Includes gain on sale of qualified IP?
Belg.	Yes if IP is further developed.	Deduction limited to 100% of pre-tax income.	Yes	No
France	Yes, subject to specific conditions	No	No	Yes
Hungary	Yes	Deduction limited to 50% of pre-tax income	No	Yes
Lux.	Yes, from non-directly associated companies	No	Yes	Yes
Neth.	Yes, but only if IP is further self-developed	No	Yes	Yes
Spain	No	Yes, 6 times the costs incurred to develop the IP	No	No
UK	Yes if further developed and actively managed	No	Yes	Yes

	Can R&D be performed abroad?	Credit for tax withheld on qualified royalty?	Year enacted	Applicable to existing IP?
Belg.	Yes, if qualifying R&D center	Yes	2007	IP granted or first used after 1/01/2007
France	Yes	Yes	2001, 2005, 2010	Yes
Hungary	Yes	Yes	2003	Yes
Lux.	Yes	Yes	2008	IP developed or acquired after 12/31/2007
Neth.	Yes for patented IP; strict conditions for R&D IP	Yes, subject to limitations	2007 / 2010	IP after 12/31/2006
Spain	Yes, but must be self-developed by the licensor	Yes	2008	Yes, can be applicable to IP posted before 1/01/2008
UK	Yes	Yes	2013	Yes can be applicable to patents granted prior to 2013

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Tax Preferential Policy for R&D activities in China

January 2012

Overall situation of R&D centers in China

- **Increasing number of R&D centers:**

  As of end of 2011, China has more than 1,500 R&D centers set up by multinational companies. More than 500 of these R&D centers were established as independent legal entities with approval of the Ministry of Commerce. The key focus of such R&D centers are automobile, chemical and pharmaceutical industries.

- **Major locations of R&D centers in China:**

  These centers have a total investment amounting to 12.8 billion US dollars and registered capital of 7.4 billion US dollars. They are mainly concentrated in coastal area, such as Shanghai, Beijing and Guangzhou.

- **Sufficient supply of talents**

  Each year China's universities graduate more engineers (over 500 thousand) than the US and Germany combined. (The number of newly graduate students amounts to 6.6 million in year 2011) The salary costs of Chinese engineers are 20% to 30% of their counterparts in US and EU. At an average age of 32, they are about a decade younger, and turning out to be just as good.

Over view of Tax preferential policies

Tax	Type	Description	IP Ownership	
			China-owned	Foreign-owned
Corporate Income Tax ("CIT")	Reduced tax rate	CIT rate of 25% could be reduced to 15%, if the entity is: •Qualified as New & High Tech Enterprise ("NHTE"); or •Qualified as Technologically-advanced Service Enterprise ("TASE")	✓ (apply for NHTE status)	✓ (apply for TASE status)
	Tax holiday	"2+3" tax holiday for newly established NHTEs in "5 + 1" Zones (e.g. Shanghai Pudong, Shenzhen, etc.)	✓	✗
	Super deduction	150% deduction of qualified R&D expenses	✓	✗
	Reduction on technology transfer income	• CIT exemption for income not exceeding RMB 5M; and • Half reduction of CIT on income in excess of RMB 5M	✓	✗
Turn-over Taxes ("business tax and value-added tax")	BT exemption	Income derived from transfer of technology, technology development and related consulting service	✓	✓
		Income derived from offshore outsourcing services	✗	✓
	VAT exemption	Provision of R&D services to foreign entities is eligible for zero tax rate (VAT Pilot Program)	✗	✓
Customs Duty ("CD")	CD exemption	Duty free importation of self-use equipment and related parts for technology improvement	✓	✓
Local Financial Subsidy	Rebate of the tax revenue retained by the local government authorities		✓	✓

Tax Preferential Policies – Corporate Income Tax

- **Reduced CIT rate :**

✓ There are around 40,000 New and high-tech Enterprises ("NHTE") approved in China by the end of 2011. Net profit of NHTE amounts to RMB 980.7 billion (USD 150.8 billion).

✓ There are more than 3,000 Technologically-advanced Service Enterprise ("TASE") approved in China by the end of 2011.

- **Super deduction:**

✓ Only qualified R&D expenses are eligible for super deduction and additional approval is required.

✓ Total R&D expenses of year 2010 is around RMD 706 billion (USD 108.6 billion).

✓ Around 50% NHTE enjoyed the super deduction (around 1.76% of total GDP).

Tax Preferential Policies – Turn-over taxes

- **Business Tax:**

✓ Income derived from technology transfer, technical services are exempt from 5% business tax. (subject to approval by the Science Bureau)

✓ Qualified offshore outsourcing services are also eligible to business tax exemption. (Subject to approval by the Ministry of Commerce)

- **Value-added Tax:**

✓ Indirect tax reform was kicked off starting from January 1st, 2012 and Shanghai has been selected as the Pilot Program area.

✓ R&D services provided to foreign companies by Pilot Enterprise and Individuals are eligible to zero-rated treatment.

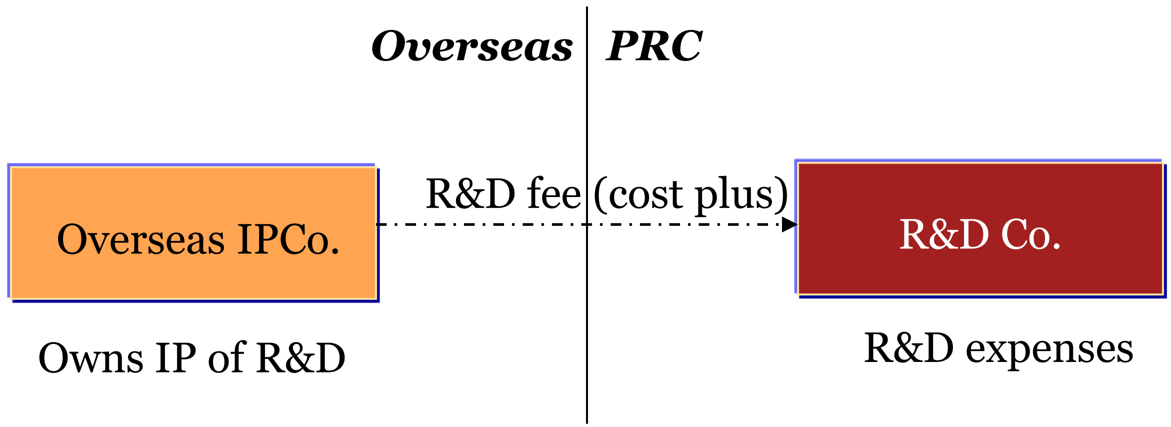
✓ Such Pilot Enterprises are also entitled to VAT refund for the input VAT credit.

Tax Preferential Policies – Customs Duty

Customs Duty Exemption on imported equipment:

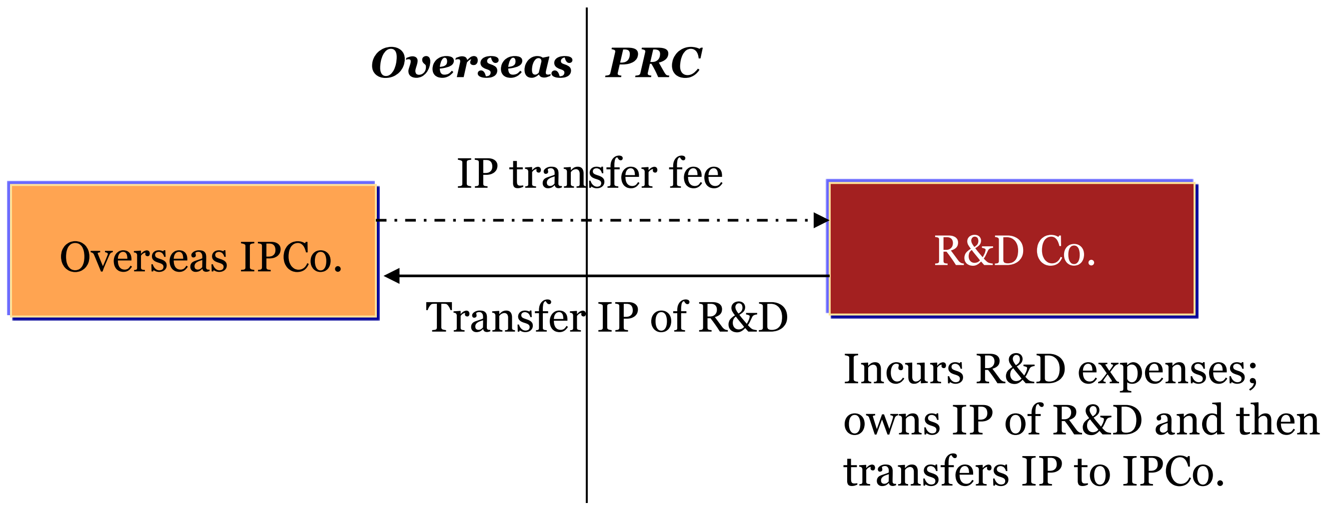
- ✓ Certain imported equipment of qualified R&D centers are eligible to import duty exemption.
- ✓ Mainly focus on equipment, key components and spare parts that cannot be manufactured in China.
- ✓ 17% import VAT will also be exempt.

Alternative R&D structures
I. Contract R&D for overseas IP hub



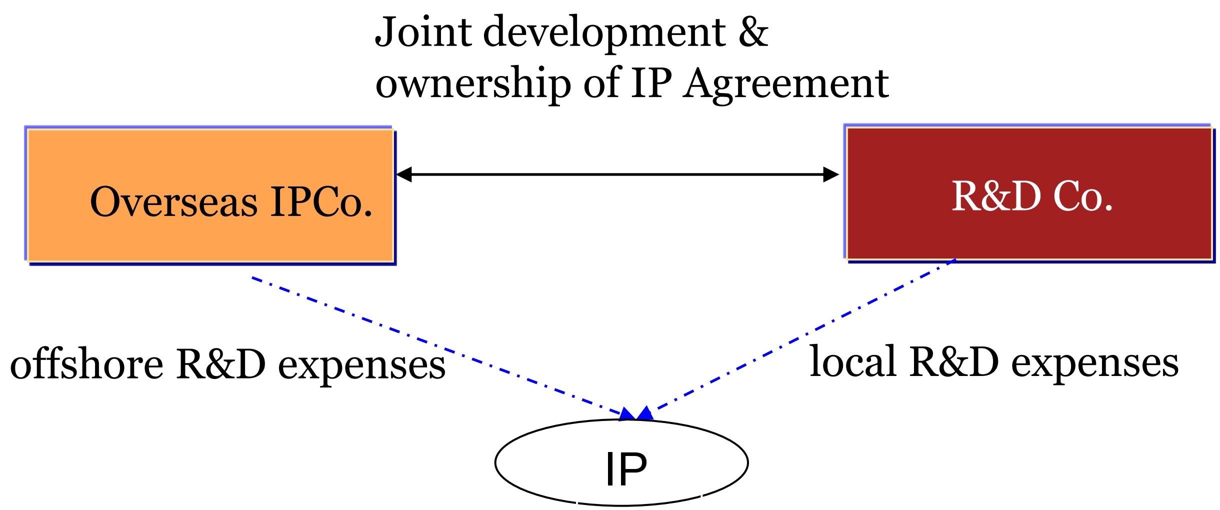
- R&D Co.'s R&D income from overseas IPCo. is exempt from BT in China (VAT is also exempt in Pilot Program).
- R&D Co. could qualify as TASE and enjoy a reduced tax rate of 15% in China.

Alternative R&D structures
II. "Develop, Own & Transfer" model



- R&D expenses incurred by R&D Co. could qualify for "Super R&D Deduction" (since it owns IP of R&D).
- R&D Co. could qualify as NHTE and enjoy CIT preferences (e.g. 15% rate, tax holiday).
- IP transfer fee received by R&D Co. from overseas IPCo. is exempted from BT in China, but subject to CIT in the hands of R&D Co.

Alternative R&D structures
III. Joint ownership model



- R&D Co. could qualify for "Super R&D Deduction" in respect of local R&D expenses since it owns IP jointly with overseas IPCo.
- R&D Co. may qualify as NHTE and enjoy CIT preferences (e.g. 15% rate, tax holiday)
- Possible allocation of offshore R&D expenses by IP Co. to R&D Co. on a cost sharing basis (deductible to R&D Co. but unclear if qualify for "Super R&D deduction"). Documentary evidence regarding cost sharing allocation policy and basis required.

Thank you

The contents of this seminar are for reference only, and cannot be regarded as either detailed explanation or legal/tax recommendations. PricewaterhouseCoopers ("PwC") is not obliged to update relevant information regarding legal and general changes. The explanation and impact of the laws and regulations widely depend on the facts and conditions of each individual case. Before obtaining professional advice from PwC client service team or other consultants, please do not act or not act according to the contents of this seminar.

The contents of this seminar are prepared based on the information and laws in effect as of May 15, 2011.

Do Tax Credits Stimulate R&D Spending? Revisiting the Effect of the R&D Tax Credit in its First Decade *

Nirupama Rao
The Wagner School
New York University †

January 2011

Abstract

This paper examines the impact of the R&D tax credit during the 1981-1991 period using both publicly available data from financial filings and confidential IRS data from federal corporate tax returns. The key advance on previous work is the use of an instrumental variables strategy based on tax law changes that addresses the potential simultaneity between R&D spending and its user cost. The results yield a range of estimates for the effect of tax incentives on R&D investment. Estimates using only publicly available data suggest that a ten percent tax subsidy for R&D yields on average between \$3.5 (0.24) million and \$10.7 (1.79) million in new R&D spending per firm. Estimates from IRS SOI data, which only reports qualified research expenditures, suggest that a ten percent reduction in the usercost would lead the average to increase qualified spending by \$2.0 (0.39) million. Analysis of the components of qualified research spending shows that wages and supplies, which comprise the bulk of qualified spending, account for the increase in research spending. Estimates from the much smaller merged sample which makes use of the more precise tax data to calculate the tax component of the usercost suggest that qualified spending is responsive to the tax subsidy. A similar response in total spending is not statistically discernible in the merged sample. The inconsistency of estimates across datasets, instrument choice and specifications highlights the sensitivity of estimates of the tax-price elasticity of R&D spending.

Keywords: R&D, Tax Credits.
JEL Classification: O38, H25, G31.

*I thank Jim Poterba and Michael Greenstone for valuable advice and encouragement. I greatly appreciate the U.S. Department of Treasury granting me access to the IRS SOI data and and particularly owe Jerry Auten, Gerry Gerardi, and Jay Mackie for their support and guidance. All errors are of course my own

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1 Introduction

In an attempt to stanch a decade-long decline in the GDP-share of private R&D spending, Congress adopted a tax credit for R&D expenditures in 1981. The Research and Experimentation Credit (R&D Credit) awards firms that increase their research spending a tax credit of up to 25 percent of their expenditures in excess of their past research spending. As the credit is incremental, the research credit offers no subsidy to firms that fail to increase their R&D spending. Along with existing provisions that allowed firms to expense R&D spending, the research credit lowers the after-tax cost of qualified research in hope of incentivizing firms to increase their R&D investments.

As the primary tax provision designed to encourage private R&D expenditures, the effectiveness of the Research and Experimentation Credit (R&D credit) has been of interest to both researchers and policymakers alike. Although early work (Eisner et al (1984)[1] and Mansfield (1986)[2]) suggested that the credit had an insignificant or modest impact on R&D spending, more recent studies have found surprisingly large user cost elasticities. Using confidential IRS data, Altshuler (1988) found that between 1981 and 1984 average effective credit rates were just a fraction—less than one-tenth—of the period's 25 percent statutory credit rate. Later studies, most notably Hines (1993) and Hall (1994), found that the R&D tax credit proffered much more bang-for-the-buck. Hines (1993) explored the effect of changes in the allocation rules of R&D expensing on the R&D activity of multinational firms. Using a special Compustat data panel describing foreign pretax earnings and foreign taxes paid

[1]Eisner, Albert and Sullivan (1984) took a natural experiment approach and made use of special survey data describing the composition of firm R&D spending to construct a difference-in-difference estimate of the effect of the R&D tax credit. They found that spending on research that qualified for the R&D tax credit grew 25.7 (5.0) percentage points faster than unqualified research spending between 1980 and 1981. They found that difference in spending growth was statistically insignificant in 1982, suggesting that the policy change did not fundamentally alter spending patterns. Comparing changes in aggregate qualified and unqualified R&D spending implicitly assumes that absent the introduction of the R&D tax credit these types of R&D spending would have increased identically; systematic spending trend differences among firms with different R&D spending mixes would violate this assumption.

[2]Mansfield (1986) compared the experiences of the US, Canada and Sweden using firm-level survey data; executives of a stratified sample of firms were asked to estimate the effect of the relevant tax incentives on the firm's R&D expenditures. According to the executives, each dollar of forgone tax revenue resulted in 30 to 40 cents of induced R&D spending.

between 1984 and 1989 for a subset of firms, Hines exploited variation in the fraction of U.S. R&D expenses firms can deduct against U.S. income for tax purposes to estimate the response of R&D spending to its after-tax price. His short-run estimates ranging from -1.2 to -1.6 and long-run estimates ranging from -1.3 to -2.0 suggest a tax-price elasticity of R&D that well exceeds unity. Although the changes in the allocation rules are conceivably exogenous, Hines' tack relies on variation in the tax treatment of R&D expenditures across firms—it essentially compares firms with and without excess foreign tax credits, an experiment that is different than the changes in the main statutory provisions of the R&D tax credit that are examined here.

The closest antecedent to this paper is Hall (1994), which used Compustat data from financial filings beginning in 1981 and ending in 1991. In her log first-difference specifications, Hall uses cross-time within-firm variation in tax positions and marginal R&D tax subsidies to estimate a short-run elasticity of -1.5 (0.3) and a long-run elasticity of -2.7 (0.8).

More recent work examining the impact of state tax credits and international experiences has found more modest elasticities (Wilson (2007), Bloom et al (2002)). Cross-country analysis by Bloom, Griffith and Van Reenen (2002) suggests much lower short- and long-run user cost elasticities. In their preferred dynamic specification they estimate a -0.14 short-run elasticity and a -1.09 long-run elasticity. Because the user cost of R&D is a function of the interest rate, which is positively correlated with R&D spending, Bloom et al worry that OLS estimates of the user cost elasticity would be biased upward. They instrument the R&D user costs with the tax component of the user cost to address this endogeneity issue as well as attenuation bias concerns. Although some countries in their sample have incremental R&D credit regimes, where high spending firms receive higher credit rates, Bloom et al do not address this potential source of bias. Wilson (2009) uses variation in state tax preferences for R&D to estimate both the impact of a state's R&D policy on R&D conducted in that state and the impact on R&D in neighboring states. Using state aggregate data he finds that R&D spending is negatively impacted by tax preferences in other states, suggesting that firms shift R&D to proximate states with lower R&D user costs. The magnitude of this response nearly offsets the in-state response of R&D to changes in the in-state user cost. Wilson concludes that the aggregate R&D user cost elasticity is small and near-zero; state subsidies draw R&D across state borders rather than encouraging a new dollar of R&D spending. His state-level analysis yields an elasticity estimate of 0.17 in the short-run and 0.68 in the long-run. Wilson assumes that all R&D subject to an incremental R&D tax credit receives the highest statutory rate, abstracting from simultaneity between R&D spending and R&D user costs.

This paper re-examines the impact of federal tax advantages for R&D between the inception of the R&D tax credit in 1981 and 1991. Data after 1991 are excluded because the credit was allowed to first lapse in 1992. Since this and other lapses likely affected firms' expectations of the after-tax user cost of R&D, the analysis here is limited to only the first 11 years after the introduction of the research credit. Furthermore, during this period the R&D credit underwent several substantial revisions that allow for an instrumental variables strategy based on tax changes. Unlike previous efforts to assess the impact of tax subsidies on R&D spending, this paper incorporates restricted-access IRS corporate return data. As explained in more detail below, the structure of the R&D tax credit makes a firm's marginal tax subsidy difficult to infer from annual R&D spending as reported in its public financial statements alone. Data from the corporate tax return allows for accurate measurement of the tax subsidy each firm faces on its marginal R&D dollar each year and allows for unbiased assessment of the impact of the tax credit on R&D expenditures.

The main contributions of this paper are the use of IRS Statistics of Income (SOI) data that accurately describe marginal credit rates and a more direct correction for potential biases due to the simultaneity of R&D spending and marginal credit rates. Tax subsidy terms constructed using only publicly available Compustat data, and constructed using IRS data, differ and the differences often vary from year to year. This finding at a minimum suggests potential measurement error in subsidy rates calculated using public use data. Instrumental variable estimates suggest that different instrument sets produce different estimates of the effect of tax subsidies on R&D expenditures. These findings raise questions about the robustness of many panel data strategies for estimating the elasticity of R&D spending.

Using an instrumental variables strategy based on tax law changes to disentangle any potential simultaneity between R&D spending and its user cost, I estimate a short-run user cost elasticity for R&D spending. The results yield a range of estimates for the effect of tax incentives on R&D investment. Estimates using only publicly available data suggest that a ten percent tax subsidy for R&D yields between \$3.5 (0.24) million and \$10.7 (1.79) million in new R&D spending by the average firm. Estimates from IRS SOI data, which only reports qualified research expenditures, suggest that a ten percent reduction in the usercost would lead the average firm to increase qualified spending by \$2 .0 (0.39) million. Analysis of the components of qualified research spending shows that wages and supplies, which comprise the bulk of qualified spending, account for the increase in research spending. Estimates from the much smaller merged sample, which makes use of the more precise tax data to calculate the tax component of the usercost, suggest that qualified spending is responsive to the tax subsidy. A similar response in total spending is not statistically discernible in the merged sample. The inconsistency of estimates across datasets, instrument choice and specifications highlights the sensitivity of estimates of the tax-price elasticity of R&D spending.

The paper proceeds as follows. Section 2 sketches the conceptual framework underlying the regression analysis. R&D is viewed as a durable input into the firm's production function. Tax subsidies are modeled as inducing relatively small changes in steady-state investments in R&D. Section 3 briefly describes key aspects of the R&D tax credit and their impact on the user cost of R&D spending. Section 4 discusses and contrasts public financial and restricted-access SOI data and details measurement issues. Section 5 lays out the empirical model and methodology, including a description of the instrumental variables used. Section 6 presents the results of different specifications using the two data sets. Section 7 concludes.

2 Conceptual Framework

Like most other R&D studies, this paper treats R&D, specifically the services of R&D capital, as an input into a firm's production function.[3] Research projects are undertaken by private firms to develop new products or new methods that increase sales. The price of output is normalized to one. The output of firm i in time t, Y_{it}, is generated via a production function with a constant elasticity of substitution (σ) between the stock of R&D capital, S_{it}, and all other inputs, I_{it}:

$$Y_{it} = F\left(S_{it}, I_{it}\right) = \left[\theta_i S_{it}^{\frac{\sigma-1}{\sigma}} + \left(1-\theta_i\right) I_{it}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where θ_i is the firm-specific CES distribution parameter. Note that σ captures both the elasticity of substitution and the user cost elasticity of R&D spending. R&D investments, R_{it}, add to the R&D capital stock, S_{it}, without adjustment frictions; R&D capital depreciates at a constant rate δ. The R&D stock is governed by:

$$\dot{S} = R_{it} - \delta S_{it} \tag{2}$$

The standard derivation of the Hall-Jorgenson user cost of capital formula can be extended to reflect both federal tax subsidies for R&D and the impact of the tax status of the firm. A firm that is taxable at marginal rate τ_{it} can expense its R&D spending in the current year and earn a tax credit at marginal rate c_{it}, which is indexed by firm because the marginal credit rate is a function of the firm's R&D spending as explained in further detail in section3.[4] Firms discount the future at a common real interest rate, r_t, purchase R&D and other inputs at prices p^{S_t} and, p^{I_t}, and face a common constant depreciation rate on

[3]Though only a small share of R&D spending is directly for capital goods, more than half of all expenditures consist of wages and fringe benefits and only 5 percent of costs are attributable to depreciation (NSF 2003), R&D expenditures are thought to buildup a stock of R&D knowledge. The service flows from this knowledge stock is the input into firm production.

[4]The corporate tax rate is indexed by firm to account for the progressivity of federal corporate taxes. In 2007 the 35 percent flat corporate tax rate applied to income greater than $18.333 million; incomes less than this level were taxed at a lower rate except for small intervals of more heavily taxed income. Some small firms subject to a marginal tax rate less than 35 percent do spend on R&D; their R&D credit rate reflects their smaller marginal tax rate.

R&D capital, δ. The taxable firm maximizes profit according to the following present-value Hamiltonian:

$$H_{it}\left(S_{it}, I_{it}, \omega_{it}\right) = \int_0^\infty \left\{ e^{-rt}\left[\left(1-\tau_{it}\right)\left(F\left(S_{it}, I_{it}\right) - p_t^I I_{it}\right) - p_t^S R_{it}\left(1-\tau_{it}-c_{it}\right)\right] - \omega_{it}\left[R_{it} - \delta S_{it} - S_{it}\right]\right\} dt \quad (3)$$

where ω_{it} it is the shadow value of R&D capital.

From the requisite first-order conditions the analogous Hall-Jorgenson arbitrage condition for the optimal R&D capital stock can be written:

$$\left(1-\tau_{it}-c_{it}\right)\left(r_t+\delta-\pi_t^S\right)p_t^S = \left(1-\tau_{it}\right)F_{S_{it}} \quad (4)$$

where τ_{it} is the marginal corporate tax rate, c_{it} is the marginal research credit rate, r_t is the common real interest rate, δ is the depreciation rate of R&D capital, π_t^S is the time-varying growth rate of R&D input prices, p_t^S is the price of R&D inputs, and F_S is the first-derivative of the production function, $F\left(S_{it}, I_{it}\right)$, with respect to R&D capital.

Note that the credit rate, c_{it}, enters the relation linearly because the depreciation base is not typically reduced by the amount of the credit. Firms are viewed as discounting at their real borrowing rates; although R&D is risky, the firms that account for the lion's share of R&D spending are large highly-rated firms that could fund their R&D by borrowing at generally low interest rates. The depreciation rate for R&D, δ, is thought to be high since a sizable fraction of R&D spending does not yield intellectual capital and goes to wages, supplies and equipment rental, none of which are durable. Since the wages comprise the bulk of R&D spending, R&D price inflation, π_t^S, should closely track wage growth for scientists and engineers.

Rearranging equation 4, the user cost of R&D capital, ρ_{it}, for a taxable firm can be written:

$$F_{S_{it}} = \rho_{it} = \frac{\left(r_t + \delta - \pi_t^S\right) p_t^S \left(1 - \tau_{it} - c_{it}\right)}{\left(1 - \tau_{it}\right)} \tag{5}$$

A nontaxable firm with k_{it} years of tax losses will not use the R&D expensing provision to offset income until those losses are exhausted; it will offset income in k_{it} years at the prevailing tax rate. Similarly, a firm that has insufficient tax liabilities to fully apply any R&D credit earned this year will carry its credit forward j_{it} years until it can fully use it. The tax terms in the user cost formula for nontaxable firms must be appropriately discounted to reflect the delayed use of the subsidies. Finally, the loss-laden firm does not contemporaneously pay taxes on income arising from current R&D services because currently accrued losses offset these earnings; but it is absorbing losses that would have otherwise remained unused and available in available in k_{it} years when the firm first reports taxable income. The user cost of the nontaxable firm must also reflect the value of these used losses. The relevant tax rate for valuing these absorbed losses is the tax rate prevailing in k_{it} years:

$$\rho_{it} = \frac{\left(r_t + \delta - \pi_t^S\right) p_t^S \left(1 - \tau_{it+k_{it}} \left(1 + r_t\right)^{-k_{it}} - c_{it} \left(1 + r_t\right)^{-j_{it}}\right)}{\left(1 - \tau_{it+k_{it}} \left(1 + r_t\right)^{-k_{it}}\right)} \tag{6}$$

where r_t is the interest rate, δ is the depreciation rate, p_t^S is the price of R&D inputs, τ_{it} is the marginal tax rate, k_{it} is the number of years until any losses are exhausted, c_{it} is the marginal research credit rate, and j_{it} is the number of years any R&D tax credits must be carried forward. Note that in the case of the taxable firm, k_{it} and j_{it} will be zero and the user cost formula will be identical to equation 5.

As noted above, the firm's marginal R&D credit rate, c_{it}, varies across firms as well as over time. Initially, the marginal credit rate was a nonlinear function of the firm's current R&D spending, its recent R&D spending and its future R&D spending. Legislative modifications to the R&D credit's provisions changed the definition of the credit and the marginal credit rates firms faced. These changes are detailed below.

3 The R&D Tax Credit

In addition to direct federal support for R&D, such as research performed by federal agencies and grants for basic and applied research, the federal government provides indirect support for privately sponsored research through the tax code. Federal tax law offers two incentives for private R&D: a deduction for qualified research spending under Section 174 of the Internal Revenue Code (IRC), and a non-refundable tax credit for qualified research spending above a base amount under IRC Section 41. These two tax advantages reduce the after-tax price of R&D investment; they are jointly referred to here as the "R&D tax credit" and their combined effect on the after-tax price of and impact on R&D spending is assessed.[5]

The Section 41 credit, known legislatively as the Research and Experimentation Tax Credit, was introduced as part of the Economic Recovery Tax Act of 1981, allowing firms to earn a tax credit on spending they were already able to expense under the existing Section 174 expensing provision. The credit is available for qualified research expenditures, which were defined as salaries and wages, certain property and equipment rental costs and intermediate materials expenses incurred in research undertaken to discover knowledge that is technological in nature for a new or improved business purpose. The tax credit was initially effective beginning July 1, 1981 and ending December 31, 1985.

In its original form the incremental tax credit was equal to 25 percent of qualified research expenditures (QREs) above a firm-specific base amount. A firm's base was its average nominal qualified spending on R&D in the previous three years, or 50 percent of current spending, whichever was greater. For the first nine years of the R&D tax credit the firm's

[5] Net Operating Loss (NOL) carry-forwards resulting from Section 174 expensing can be carried forward up to 20 years—five years longer than Section 41 tax credits can be carried forward. Although this discrepancy in carry forward life has real implications for some firms, this level of detail is beyond the descriptive capability of the Compustat and IRS data used here and is ignored.

base was defined as:

$$B_{it} = \text{Base for R\&D Credit} = max\left[\frac{1}{3}\left(R_{it-1} + R_{it-2} + R_{it-3}\right), 0.5R_{it}\right] \text{ for } t\text{=1981-1989} \tag{7}$$

where R_{it} is R&D spending by firm i in year t.

Because a firm's base was a moving average of its past spending, additional research spending in the current year increased the firm's base by one-third of the increase in each of the subsequent three years. This 'claw-back' muted the credit's incentive effects; some firms were even left with negative marginal credit rates.

The marginal credit rate between 1981 and 1988 is:

$$c_{it} = \begin{cases} 0 & \text{if } R_{it+m} < B_{it+m} \text{ for } m = 0\text{–}3 \\ -s_t\left\{\frac{1}{3}\sum_{m=1}^{3}(1+r_t)^{-(m+k_{it})}\right\} & \text{if } R_{it} < B_{it} \text{ and } B_{it+m} < R_{it+m} \\ & \text{and } R_{it+m} < 2B_{it+m} \text{ for any } m = 1\text{–}3 \\ s_t\left\{(1+r_t)^{-j_{it}} - \frac{1}{3}\sum_{m=1}^{3}(1+r_t)^{-(m+k_{it})}\right\} & \text{if } B_{it+m} < R_{it+m} < 2B_{it+m} \\ & \text{for any } m = 0\text{–}3 \\ s_t\left\{\frac{1}{2}(1+r_t)^{-j_{it}} - \frac{1}{3}\sum_{m=1}^{3}(1+r_t)^{-(m+k_{it})}\right\} & \text{if } R_{it} > 2B_{it} \text{ and } B_{it+m} < R_{it+m} \\ & \text{and } R_{it+m} < 2B_{it+m} \text{ for any } m = 1\text{–}3 \end{cases}$$

where s_t is the statutory credit rate, k_{it} is the number of years until any tax losses are exhausted, j_{it} is the number of years the credit must be carried forward (it will be negative if it can be carried back), and r_t is the real interest rate. The negative summation term in the above equation represents the claw-back provision.

In the credit's original incarnation, a firm's marginal credit rate was highest when its current year R&D spending, R_{it}, exceeds its current base amount, B_{it}, but is anticipated to not exceed its base in the following three years. Spending less than its base amount, the firm would not be eligible for credits in the next three years and thus not subject to the claw-back provision. In this case, if it has sufficient tax liabilities to fully offset its R&D tax credit, the firm's marginal credit rate is the statutory credit rate, s_{it}, or half the statutory credit rate if its current year spending exceeds twice its base. In terms of the preceding equation, if the firm is eligible for the full statutory rate, its current spending would exceed its base but be less than twice its base, and sufficient tax liabilities would mean j_{it} is zero. If the firm expected its spending in the subsequent three years to be below its base amounts, the second summation term would be zero. From 3.5 to 9.5 percent of firms (5 to 16 percent of firms earning a credit) between 1981 and 1990 had marginal credit rates equal to the statutory rate, depending on the year.

Because a firm's base can never be less than half of current expenditures, when R&D spending exceeds twice its historically defined base, the redefined base is increased 50 cents for every additional dollar of R&D spending. When this is the case, the first additive term of the preceding equation is halved, and the maximum marginal credit rate is reduced from 25 percent to 12.5 percent.

A firm that claimed the tax credit but had insufficient current-year tax liabilities to offset was allowed to carry the excess credit back up to three tax years and/or forward up to 15 tax years; carrying back (forward) the credit increases (decreases) the present value of the R&D credit. In other words, jit can range from -3 to 15.

The Tax Reform Act of 1986 extended the credit through 1988, but also reduced the statutory credit rate from 25 to 20 percent.[6] This rate reduction was not motivated by any careful assessment of the tax credit, but was instead part of one of the primary goals of TRA86—reducing the differences in tax burdens among major business asset categories (CRS 2007). The tax credit was extended through 1989 by the Technical and Miscellaneous

[6] TRA86 also folded the tax credit into the General Business Credit under IRC Section 38, subjecting the credit to a yearly cap. The tax credit was also expanded to include research contracted to universities and certain other nonprofits. The definition of QREs was also changed so that it applied to research aimed at producing new technical knowledge deemed useful in the commercial development of new products and processes. These changes in the definition of QRE are beyond the capability of the data, including the IRS data, used here as research expenditures are only reported in terms of contemporaneous definitions.

Revenue Act of 1988, which also reduced the total tax preference for R&D by requiring firms to reduce the tax credit they claim by half the value of any deductions they claim under Section 174.[7] This partial recapture of the credit effectively cut a firm's marginal credit rate from 20 percent to 16.6 percent if its R&D spending exceeded its base by less than 100 percent, and from10 to 8.3 percent if its R&D spending exceeded its base by more than 100 percent. The marginal credit rate in 1989 is:

$$c_{it} = \begin{cases} 0 & \text{if } R_{it+m} < B_{it+m} \\ & \text{for } m = 0\text{-}3 \\ -s_t\left(1-\frac{1}{2}\tau_{it}\right)\frac{1}{3}\sum\limits_{m=1}^{3}(1+r_t)^{-(m+k_{it})} & \text{if } R_{it} < B_{it} \text{ and } B_{it+m} \le R_{it+m} \\ & \text{and } R_{it+m} < 2B_{it+m} \text{ for any } m = 1\text{-}3 \\ s_t\left(1-\frac{1}{2}\tau_{it}\right)\left\{(1+r_t)^{-j_{it}} - \frac{1}{3}\sum\limits_{m=1}^{3}(1+r_t)^{-(m+k_{it})}\right\} & \text{if } B_{it+m} \le R_{it+m} < 2B_{it+m} \\ & \text{for any } m = 0\text{-}3 \\ s_t\left(1-\frac{1}{2}\tau_{it}\right)\left\{\frac{1}{2}(1+r_t)^{-j_{it}} - \frac{1}{3}\sum\limits_{m=1}^{3}(1+r_t)^{-(m+k_{it})}\right\} & \text{if } R_{it} \ge 2B_{it} \text{ and } B_{it+m} \le R_{it+m} \\ & \text{and } R_{it+m} < 2B_{it+m} \text{ for any } m = 0\text{-}3 \end{cases}$$

where τ_{it} is the marginal tax rate, s_t is the statutory credit rate, k_{it} is the number of years until any tax losses are exhausted, j_{it} is the number of years the credit must be carried forward (it will be negative if it can be carried back), and r_t is the real interest rate. The additional corporate tax rate term, $\left(1-\frac{1}{2}\tau_{it}\right)$, in the marginal credit formula for 1989 reflects the recapture of half of the deduction. In 1989 the credit was revamped. The claw-back provision created dynamic disincentives for current R&D spending, leading to negative marginal credit rates for some firms and lower than statutory rates for many others. Addressing this concern, the Omnibus Budget Reconciliation Act of 1989 altered the

[7]Firms could alternatively reduce the depreciation basis of their R&D expenses by the value of the credit; this was less tax advantageous since losses have longer carry-forward periods than credits. Firms are assumed to have reduced the value of their credit rather than the value of their deduction.

base formula, replacing the moving average with a base unrelated to recent R&D spending. The new formula for the base was the greater of 50 percent of current qualified spending, and the product of the firm's average gross receipts in the previous four tax years and the firm's "fixed-base percentage," a measure of historic research intensity. The firm's fixed base percentage is its ratio of total qualified R&D expenditures to total gross receipts between 1984 and 1988, subject to a 16 percent ceiling. The base formula from 1990 on is:

$$B_{it} = max\left[\frac{1}{4}\sum_{m=1}^{4} G_{it-m}\min\left(\left(\sum_{n=1984}^{1988} R_{in}/\sum_{n=1984}^{1988} G_{in}\right), 0.16\right), \frac{1}{2}R_{it}\right] \quad (8)$$

where G_{it} is gross receipts or sales and R_{it} is the R&D expenditures of firm i in year t. As the base definition changed, the tax credit subsidy on the marginal dollar of R&D spending changed as well. Beginning in 1990 the marginal credit rate is:

$$c_{it} = \begin{cases} 0 & \text{if } R_{it} < B_{it} \\ s_t\left(1-\tau_{it}\right)\left(1+r_t\right)^{-j_{it}} & \text{if } B_{it} < R_{it} < 2B_{it} \\ \frac{1}{2}s_t\left(1-\tau_{it}\right)\left(1+r_t\right)^{-j_{it}} & \text{if } R_{it} > 2B_{it} \end{cases}$$

where again, s_{it} is the statutory R&D credit rate in year t, r_t is the interest rate, τ_{it} is the firm's marginal corporate tax rate, and j_{it} is the number of years of tax losses.

Start-ups, firms lacking gross receipts or QREs for three of the five years between 1984 and 1988, were assigned a three percent fixed-base percentage. OBRA89 extended the credit through 1990 and required firms to reduce their Section 174 deduction by the entire amount of research credits claimed. The Omnibus Budget Reconciliation Act of 1990 and Tax Extension Act of 1991 extended the research credit through 1991 and 1992 respectively. Pay-as-you-go rules adopted as part of OBRA90 were a major obstacle to more lasting extension (CRS 2007). From its inception until 1992 the credit was always extended before it expired. The first of several retroactive extensions occurred in 1993 after the credit was allowed to lapse in 1992. Even the retroactive extension covered only the last two quarters of 1992. Because this and other lapses likely affected firm expectations, the analysis here is limited to just the first 11 years of the R&D tax credit. Table 2.1 provides a summary of the legislative history of the R&D tax credit.

If corporate tax rates are expected at the time of R&D investment to remain constant in the future, they have no impact on R&D spending decisions—firms expect to expense their investments and pay taxes on the income from those investments at the same rate. The 1980s, however, were a time of changing corporate tax rates. The value of the Section 174 expensing provision was reduced by the Tax Reform Act of 1986; as the corporate tax rate was reduced to 40 percent in 1987 and to 34 percent in 1988, the benefit of expensing fell in parallel. If firms expected these reductions in the corporate tax rate, they would have invested in R&D with a higher cost of capital in mind. These corporate tax rate changes and their impact on the after-tax cost of R&D are assumed to have been expected by firms and are part of the analysis presented here. Taken together, changes in the expensing provision and tax credit significantly affected the user cost of R&D; their joint impact on the user cost of the marginal dollar of R&D spending is assessed below.

4 Data

The analysis presented here draws on two data sources, public data that has previously been used to assess the impact of the R&D tax credit and restricted-access IRS Statistics of Income (SOI) data that has not previously been used to estimate the user cost elasticity of the R&D credit. Each of these data sets has its advantages and disadvantages as does their combined use.

4.1 IRS Statistics of Income (SOI) Data

The IRS SOI data are drawn from a panel sample of corporate tax returns. The data for each firm-year observation comes from the firm's basic tax return, Form 1120. Data items relating to R&D spending are pulled from the firm's Form 6765, part of its Form 1120. The data report the firm's annual qualified R&D expenditures, base amount, tentative R&D tax credit, and limitations due to insufficient tax liabilities among other details. SOI data provide an accurate measure of the actual credit rates firms face each year on their marginal dollar of R&D spending. Only SOI data describe qualified spending with enough detail for this level of accuracy. But for all the detail and accuracy the SOI data afford, they have limitations as well. First, is the issue of censoring. A firm only reports the details of its research spending in those years when it applies for the R&D tax credit; in years where it will not earn a credit, it is unlikely to complete Form 6765. Thus in years when the firm does not apply for a credit, its qualified spending is not known (SOI data report missing values as zeros.) So as not to drop these observations, I assign firms that have previously claimed the R&D credit, but did not complete Form 6765 a zero marginal credit rate. Effectively, I assume that firms are not leaving potential R&D tax credits on the table. Only firms that have ever claimed the R&D tax credit, that is filed a form 6765 as part of its 1120 are included in the sample used in the analysis. This amounts to a sample of 3,500 and 6,500 firms per year; the exact count is reported in the tables. The qualified spending of these 'missing' firms remains unknown, however. It is treated as it appears in the data, as a zero, but this likely understate R&D spending; robustness checks that limit the sample to only those firms that complete Form 6765 each year and analysis that also makes use of public data provide checks for this treatment. Second, IRS data only report qualified research expenditures. Although these are exactly the type of expenditures that are needed to accurately calculate the marginal credit rate, we are not only interested in the impact of tax subsidies on these expenditures. If firms respond to larger tax subsidies by shifting their R&D spending from unqualified to qualified spending, we will interpret the impact of the R&D tax credit differently than if they are increasing total research spending by the same amount they are increasing qualified spending. IRS data do not provide any sense of how a firm's non-qualified spending responds to subsidies for qualified spending.

4.2 Compustat Data

Compustat data are drawn from firms' annual SEC (10-K) filings. The Compustat sample includes essentially all publicly traded firms that report the information required to compute their marginal R&D tax credit rates. There are roughly between 1,200 and 1,800 firms per year in the Compustat sample. These data have two key advantages. Compustat data are available for years prior to the introduction of the R&D credit in 1981. Financial statements provide a more comprehensive measure of R&D spending. Nonetheless, Compustat data have three major weaknesses.

First, because Compustat data describe only publicly traded firms, large firms are over-represented in the sample. NSF surveys report that between 1981 and 1992 firms with at least 5,000 employees conducted more that 80 percent of all R&D, suggesting that data concerning large public firms will describe the lion's share of R&D dollars. Nonetheless, if private firms are more (or less) responsive to changes in the tax-price of R&D, estimates based on the Compustat data understate (or overstate) the effectiveness of the tax credit.

Second, the accounting rules that govern financial reporting differ from the Internal Revenue Code (IRC) in their definition of R&D. A firm's marginal credit rate is a function of its qualified R&D spending, not its total spending as reported in its financial statements. To qualify for the federal tax credit, R&D expenditures must meet a set of criteria relating to the experimental and technological nature of the project and the stage of the product development it aims to enhance. The R&D expenses reported in financial filings (referred to here as total R&D spending) conform to a broader definition that includes both R&D conducted abroad and domestic research expenditures that do not qualify for the R&D tax credit because they fail to meet the experimental and technological criteria.

If firms respond to changes in subsidies for qualified R&D by changing their qualified and non-qualified spending shares, constructing the tax component of the firm's user cost of R&D using only data describing total R&D spending will lead to a biased measure of the usercost. For example, if firms increase the qualified share of their spending when subsidies are high, the effective credit rate could be understated if this disproportionate increase in qualified spending lifts the firm's spending above its base or the effective credit rate could be overstated if the increase in qualified spending leaves the firm above twice its base level. Because a firm's credit rate is determined by its relative QREs, changes in the composition of spending can affect credit rates.

Using the broader measure of R&D will result in non-classical mis-measurement of the tax-price, which is a function of qualified R&D spending. Only SOI data can overcome this measurement issue. Similarly, because financial data do not describe unused previously earned tax credits, the present value of currently earned R&D tax credits may be overstated; overstating the value of the credit understates the price of R&D, potentially under-estimating the magnitude of the tax-price elasticity.[8]

Third, firms only report R&D expenditures in their financial statements if these expenditures are "material" by accounting standards. The data are therefore censored with a firm-specific threshold. To assess the influence of materiality censoring, robustness checks report the results of a specification limited to only those firms with data in all years and a specification employing a control function to correct for selection.

Combining IRS and Compustat data overcomes many of the weaknesses of the individual datasets. Measuring the impact of the accurately measured after-tax user cost (from SI data) on total (from Compustat data) R&D spending can gauge whether any responsiveness of qualified spending is due primarily to shifting. Furthermore, research spending is likely to be reported in Compustat even in years when the firm does not complete its Form 6765 because it fails to earn a credit. Materiality remains an issue, however. The main disadvantage of the merged sample is size. Because the IRS data sample describes private and public firms, only a fraction are public firms and a smaller fraction still ever apply for the R&D tax credit and have sufficient data to compute their marginal credit rates. Thus the merged sample

[8]This lack of information on other tax credits is even more important after 1986 when the R&D tax credit was folded into the General Business Credit (GBC). The GBC not only caps the total amount of credits that can be used in any year but also prescribes the order in which they must be used. A firm that has a lot of higher priority credits would value currently earned R&D credits less.

consists of fewer than one thousand firm-year observations.

4.3 Measuring R&D Expenditures

Using Compustat data to determine whether a firm's current year spending qualifies it for an R&D tax credit and if it is subject to the 50 percent of current year spending limitation (i.e. whether current year qualified spending exceeds the firm's base or twice its base) incorrectly assesses the firm's credit status for 44 percent of the 755 firm-year observations that appear in both the Compustat data, drawn from financial statements, and the IRS data. For the average firm over the whole period, qualified research was 38 percent of total research. Among firms with positive QREs, the average firm spent 68 percent of its total research expenses on qualified research, but weighting by QRE the average falls to 56 percent, meaning that qualified spending represented a smaller a share of total spending for firms with high QREs. Table 2.2 illustrates the heterogeneity in the ratio of QREs to total R&D as reported in financial statements for the subset of firms that appear in both data sets and have sufficient data to be included in later regression analysis.[9] For five of the sample's eleven years more than half of the firms reported no QREs but did report R&D expenditures in their financial statements; most of these years follow the 1986 absorption of the R&D credit into the General Business Credit (GBC). Qualified research ranged between 40 and 80 percent of total research for the lion's share of the sample that reported non-zero QREs. For a non-trivial share of the sample, on average 12 percent, qualified spending represented more than 90 percent of its total spending.

The distribution of qualified spending shares varies over time, including between years when the parameters of the R&D credit changed. In 1986 when the R&D credit was folded into the GBC the share of firms reporting no QREs but still reporting research expenses for financial purposes rose by more than 11 percentage points while the share of firms for which

[9]The accounting definition of R&D includes all the categories that comprise IRS QREs but is less strict in terms of the experimental and technological nature of these expenditures. For example, expenses related to testing and the modification of alternative products is classified as R&D for accounting purposes but generally do not qualify for the R&D tax credit.

qualified research represented between 20 and 80 percent fell by more than 12 percentage points. Again in 1990 when the credit was revamped and base amounts were redefined, the distribution changed markedly. The fraction of firms reporting no QREs fell by more than ten percentage points, mostly accruing to the 20 to 40 percent and 60 to 80 percent categories. The distribution varied in other years as well, some when other policy changes occurred such as 1985, but also between years when the credit's structure remained unchanged such as between 1983 and 1984. Although Table 2.2 only describes the evolution of the distribution of qualified spending shares for a limited sample of firm that report R&D spending in both data sets, it makes clear that the ratio of qualified to total R&D spending varied considerably from year to year. This type of variation makes clear that using Compustat data describing total R&D expenditures to construct marginal credit rates will often lead to incorrect measures of the marginal tax subsidy for R&D investment.

4.4 Computing the User Cost

Each firm's marginal credit rate is computed according to the prevailing structure of the R&D tax credit and its tax position as described above in marginal credit rate equations above. Credit rates are computed both using Compustat data and IRS data; as explained above, credit rates constructed from Compustat data are likely to be inaccurate but are widely used in previous studies that rely on publicly available data. Further details of the formulas' components can be found in the appendix.

Table 2.3 reports the average percentage reduction in R&D user costs due to tax preferences, the share of firms eligible for an R&D tax credit and the fraction with negative marginal credit rates. Because actual receipt of a credit is not observed in public financial data, a firm is considered eligible for an R&D credit if its R&D spending exceeds its base; firms not receiving a credit are firms who report enough information to calculate their marginal credit rates, but whose R&D expenditures do not exceed their base amounts. In the SOI panel data a firm is considered eligible for an R&D tax credit if it claims a positive tentative R&D tax credit on form 6765 of its corporate return.[10] Changes in tax policy and changes in R&D spending both drive changes in the tax-adjustment term of the user cost of R&D, making it difficult to infer the impact of policy changes from observed user costs. When only the expensing allowance was in place, tax factors did not affect the user cost of a firm that had sufficient tax liabilities in the year it expensed its R&D spending; changing tax rates did affect the user costs of firm who carried forward their losses. The introduction of the R&D credit in 1981 reduced the average tax-adjustment term from near unity to 0.914 according to IRS SOI corporate return data as shown in Table 2.3.

The average tax-adjustment term according to the Compustat data, which only reports total R&D spending, was 0.884 in 1981, three percentage points less than the average in the IRS sample. This is largely because the IRS sample contains a larger fraction of firms that face negative marginal credit rates, 24.1 versus 14.9 percent, which reduces the average subsidy level. These negative rates are driven by firms that fail to earn a credit in 1981 but face higher bases in subsequent years when they do qualify for a credit; in the Compustat data 65.7 percent of firms earned a credit in 1981, but according to the IRS sample only 52.1 percent for firms earned a credit. The two samples are comprised of largely different firms and dissimilarities in the averages in Table 2.3 reflect both the inaccuracy of calculations based on the Compustat data and differences in the composition of the samples. Between 1982 and 1984 the Compustat data suggest a higher average user cost than the IRS data with differences between three and six percentage points; in part this is driven by a much larger share of negative credit rate firms in the Compustat sample during these years. Average user costs converge beginning in 1985 and continue to track through 1988. For the last three

[10] A firm's tentative tax credit is the product of the statutory credit rate (including any decrease in the rate due to expensing after 1989) and the excess of its qualified research spending over its base amount, subject to the 50 percent of current research spending limit. It is the IRS analogue to the definition of eligibility I use in the Compustat data. The actual credit a firm realizes in a given tax year also includes any R&D credits carried back or forward and any flow-through credits from partnerships, subchapter S corps, estates or trusts, and is limited by its current year pre-credit tax liability. The order in which credits are applied in calculating the firm's pre-R&D tax credit tax liability varied slightly from year to year, but in general the R&D credit was a more senior credit. Eligibility was measured using tentative rather than total allowable R&D credit for comparability reasons and because total allowable credit data is not available for all years, particularly after the R&D tax credit was folded into the GBC.

years of the sample average user costs are four to five percentage points higher in IRS sample than the Compustat sample.

Examining the variation in average tax-adjustment factors over time in the IRS sample provides a sense of how the tax subsidy affected true user costs. The five percentage point reduction in the statutory R&D credit rate in 1986 coincided with a rise in the tax-adjustment term from 0.906 in 1985 to 0.94 in 1986 and finally to 0.947 in 1987 the first year the rate reduction was in place for a full year; the nearly nine percentage point drop in the share of firms eligible for the R&D credit over the two-year period, however, suggests other forces were also at play. Other factors countervailed the impact of partial credit recapturing in 1989, leading to only a small increase in the tax-adjustment term of the user cost. The 1990 reformulation of the R&D credit, which eliminated the claw-back provision and complete credit recapture, barely affected average tax subsidy or the credit recipiency rate.

Although the Compustat tabulations show a nearly twelve percentage point decline in the fraction of firms qualifying for a credit—a pattern consistent with the findings of Gupta, Hwang and Schmidt (2004)—this decline in 1990 is not apparent in the more accurate IRS data. Between five and ten percent of firms were subject to negative credit rates between 1982 and 1990 when the claw-back provision was eliminated; their average marginal credit rate was roughly -8 percent. Firms in several situations could face negative marginal credit rates. For example, assuming tax liabilities in all years and a three percent real interest rate, a firm whose spending this year exceeds twice its base but for the next three years lies between 100 to 200 percent of its base would have faced a marginal credit rate of -11.1 percent under the 1982 to 1985 regime, -8.9 percent under the1986 to 1988 regime and -7.4 percent in 1989. The unusually high fraction of firms that had negative credit rates in 1981, nearly a quarter of firms were tax disadvantaged by marginal R&D spending, may be due by delays in increasing research spending in reaction to the credit's introduction. Firms may not have been able increase their spending enough to qualify for a credit in 1981 but every dollar they did spend increased base amounts in subsequent years, leading to negative marginal credit rates. The 1990 reformulation improved incentives for marginal R&D investment for a substantial fraction of firms.

The averages presented in Table 2.3 belie substantial heterogeneity in the impact of tax preferences on firm user costs. Using confidential IRS data Altshuler (1988) also found substantial heterogeneity in the effective R&D tax credit rates firms faced depending on their near-term R&D spending pattern and tax status. Table 2.4 provides more detail regarding the dispersion of tax-adjustment factors each year according to the IRS data. In 1980, prior to the introduction of the R&D credit, in the Compustat sample tax policy had no impact on R&D user costs for more than 80 percent of firms; tax loss carry-forwards decreased the present discounted value of the Section 174 deduction and increased R&D user costs for the remaining firms. Once the R&D tax credit was adopted in 1981, in the IRS sample few firms—roughly five percent—had user cost tax-adjustment factors of one since even firms ineligible for a credit in the current year were increasing their bases for the following three years with every additional dollar they spent on R&D. Between 1981 and 1989, 53.2 percent of firms on average had tax-adjustment factors that ranged between 0.95 and 1.25. Average tax-adjustment factors were above 0.75 and below 1.25 for nearly 89 percent of firms over the same period. A substantial fraction of firms, however, experienced much higher and much lower user costs due to tax factors prior to the 1990 reform. Some firms, as many 11.1 percent of firms in 1981, experienced marginal credit rates so negative as to push their tax-adjustment factors above 1.25; for eight firms between 1981 and 1985 tax factors increased their user costs by more than 150 percent. During the same period, up to 18.8 percent of firms had marginal R&D tax credit rates so high that tax preferences reduced their user cost by 25 percent or more. After the 1990 reform, no firm was subject to a negative marginal credit rates, depopulating the right tail of the tax-adjustment factor distribution. Some firms, as many or even more than before, continued to have tax-adjustment factors that modestly exceeded unity after the 1990 base redefinition—firms with zero (99.2 percent) or low marginal credit rates (0.8 percent) and at least one year of tax losses—the mean tax-adjustment factor of these firms was 1.033. Starting in 1990, all firms in the sample had tax factors between 0.75 and 1.25 as fewer firms had tax factors in the tails of the distribution; firms were more concentrated between 0.75 and unity than in the preceding half-decade. In effect the 1990 reformulation eliminated both very high and very low tax-adjustment factors, but largely left the fraction of firms receiving a credit and average tax subsidy rates unchanged.

5 Empirical Model

Applying the arbitrage condition described in equation 4 to the CES production function yields the factor demand equation: $S_{it} = \theta_i^{\sigma} Y_{it} \rho_{it}^{-\sigma}$. The user cost, as laid out in Section 2, is a function of the firm's current R&D spending, the relationship between the firm's spending and its base this year and for as long as the next three years, its loss position, and the corporate tax rate. Again, the Hall-Jorgenson tax-adjusted user cost of R&D capital per dollar of investment is:

$$\rho_{it} = \frac{\left(r_t + \delta - \pi_t^S\right) p_t^S \left(1 - \tau_{it+k_{it}} \left(1 + r_t\right)^{-k_{it}} - c_{it} \left(1 + r_t\right)^{-j_{it}}\right)}{\left(1 - \tau_{it+k_{it}} \left(1 + r_t\right)^{-k_{it}}\right)} \tag{9}$$

where r_t is the interest rate, δ is the depreciation rate, π_t^S is the one-year growth rate in the prices of R&D inputs, P_t^S is the price of R&D inputs, τ_{it} is the marginal corporate tax rate, j_{it} is the number of years the credit must be carried forward (it will be negative if it can be carried back), k_{it} is the number of years until any tax losses are exhausted and c_{it} is the marginal R&D credit rate. The log linear form of the factor demand equation forms the empirical foundation of most previous empirical analyses of the cost elasticity of R&D and is the initial basis of the analysis presented here. Differencing the log linear equation to purge any unobserved firm heterogeneity yields the following regression equation:

$$\log\left(\frac{S_{it}}{S_{it-1}}\right) = \sigma \log\left(\frac{\rho_{it}}{\rho_{it-1}}\right) + \eta \log\left(\frac{Y_{it}}{Y_{it-1}}\right) + \epsilon_{it} \tag{10}$$

In the absence of adjustment costs, the optimal stock of R&D capital will be attained each period in accordance to any changes in the tax or non-tax terms of the user cost. I assume that the flow of R&D services in a year is proportional to R&D investment. Under these assumptions, the change in the R&D capital stock will be captured by the change in R&D investment. Equation 10 can be written instead in terms of the log-difference in R&D investment:

$$\log\left(\frac{R_{it}}{R_{it-1}}\right) = \sigma \log\left(\frac{\rho_{it}}{\rho_{it-1}}\right) + \eta \log\left(\frac{Y_{it}}{Y_{it-1}}\right) + \epsilon_{it} \tag{11}$$

Aggregate macroeconomic factors such as technology opportunities, changes in U.S. patent policy and IRS regulations, and aggregate demand will affect firm R&D decisions. Year fixed effects are added to the model to absorb these potentially confounding factors. I assume that the non-tax components of the cost of capital, $\left[r_t + \delta\pi_t^S\right] p_S^t$, together vary over time but not across firms and time. Since ρ_{it} enters the regression in log form, under my assumptions, $\left[r_t + \delta\pi_t^S\right] p_S^t$ is fully absorbed by the year fixed effects, leaving just the tax factor:

$$\lambda_{it} = \frac{\left(1 - \tau_{it+k_{it}}\left(1+r_t\right)^{-k_{it}} - c_{it}\left(1+r_t\right)^{-j_{it}}\right)}{\left(1 - \tau_{it}\left(1+r_t\right)^{-k_{it}}\right)} \tag{12}$$

to vary across firms and over time. The regression equation becomes:

$$\log\left(\frac{R_{it}}{R_{it-1}}\right) = \sigma \log\left(\frac{\lambda_{it}}{\lambda_{it-1}}\right) + \eta \log\left(\frac{Y_{it}}{Y_{it-1}}\right) + \chi_t + \epsilon_{it} \tag{13}$$

As was explained in Section 3, a firm's R&D tax credit rate is a non-monotonic function of its R&D spending. A firm whose spending is less than its base receives a zero credit and has a zero marginal credit rate; a firm whose spending exceeds its base, but is less than twice its base receives a credit equal to the product of the effective statutory rate and its spending above its base and has a marginal credit rate equal to the effective statutory rate; a firm whose spending exceeds twice its base receives a credit equal to the product of the effective statutory rate and its spending above its base and has a marginal credit rate equal to one-half of the effective statutory rate. A firm's marginal R&D credit rate and it R&D spending level are clearly jointly determined; the term capturing the tax-price change, $\log(\lambda_{it}/\lambda_{it-1})$, is correlated with ϵ_{it}. For example, if there is a positive shock to R&D spending ($\epsilon_{it} > 0$) then, due to the structure of R&D tax credit, the marginal credit rate could mechanically increase if the firm was otherwise below its base or decrease if the firm was otherwise above its base. An OLS regression of equation 13 would therefore lead to a biased estimate of the behavioral elasticity.

To disentangle this endogeneity I rely on an instrumental variables strategy similar to those Auten and Carroll (1999) and Gruber and Saez (2002) use in studying individual taxpayer decisions. The strategy to build instruments for the user cost variable, $\log(\lambda_{it}/\lambda_{it-1})$, is to compute λ_{it}^{S}, the marginal tax-price the firm would face in year t if its real R&D spending did not change from the previous year. The natural instrument for the actual change in the tax factor of the after-tax user cost, $\log(\lambda_{it}/\lambda_{it-1})$ is the difference in the logarithms of the firm's "synthetic" tax factor under current law and their actual lag tax price, $\log\left(\lambda_{it}^{S}/\lambda_{it-1}\right)$. The instrument by construction eliminates the effect of R&D spending changes on the change in tax price so that the synthetic change in tax price only reflects the exogenous changes in the provisions of the R&D tax credit. It is the exogenous changes in the effective tax price of R&D spending due to changes in the corporate tax code and provisions of the R&D credit that are the source of identification of the behavioral response. Firm fixed-effects purge firm-specific correlation in the evolution of R&D spending while time fixed effects purge changes in R&D spending common across all firms. The resulting residual variation in the tax-price that identifies the estimated elasticity arises from within-firm changes in the tax-price of R&D relative to the changes experienced by the average firm. In other words, the identifying variation measures how a firms tax subsidy compares with its own average subsidy across time and the average subsidy of other firms within a given year.

Only observations from years where a tax policy change went into effect are used in the analysis.[11] The key exclusion restriction is that the constructed synthetic tax factor does not affect R&D spending other than through the actual tax factor, conditional on firm and year fixed effects and sales. In later regressions, as explained in section 6, a polynomial in lagged R&D spending is added as a control to account for reasons other than the tax price why firms in different parts of the R&D spending distribution might experience different patterns of R&D growth. These added controls tighten the exclusion restriction; the identifying assumption now only assumes that the R&D spending distribution is not evolving on its own in a way that is correlated with the year-specific changes in the tax treatment of R&D. Given the strong nonlinearities of the firm-specific credit function, this assumption seems innocuous.

Table 2.5 presents a comparison of average actual and synthetic tax-adjustment factors by year; the actual tax-adjustment factor averages differ from those in Table 2.2 because the sample of firms is constrained to those that report sufficient data to also construct the synthetic factor, namely the first lag of R&D spending. Between 1985 and 1986, when the statutory credit rate fell from 25 to 20 percent, the actual tax-adjustment term increased by 3.8 and 4.5 percentage points in the Compustat and SOI data respectively while the synthetic tax-adjustment term increased similarly in the SOI data but by more than 15 percentage points in the less accurate Compustat data. Comparing 1986 synthetic tax factors to 1985 actual tax factors, which are both a function of 1985 R&D spending, shows that in the IRS data tax changes led to a decrease in average user costs while the Compustat data point to a marked nearly 10 percentage point increase, further highlighting the difficulty of using Compustat data.[12] In the Compustat data average actual tax factors fell by 1

[11] The years used are 1982, 1986, 1987, 1988, 1989 and 1990. For a summary of the changes made to the R&D tax credit in these years, please see Section 2 or Table 2.1. Data from 1982 are used in lieu of data from 1981 because the 1982 was the first full year the credit was in effect.

[12] In the much smaller sample of observations found in both the Compustat and SOI data the pattern of a decrease between 1985 actual and 1986 synthetic in IRS data and an increase in Compustat data also holds.

percentage point with the introduction of recapturing in 1989 but barely moved in the IRS data; in both datasets synthetic factors increased by roughly 1.5 percentage points. The 1990 base redefinition reduced user costs as is made clear by the 2.4 and 5.4 percentage point differences between 1989 actual and 1990 synthetic tax factors in the Compustat and SOI data, respectively. Actual tax factors fell by less or increased slightly in the case of the SOI data, signaling that firms also changed their R&D spending such that their marginal credit rates decreased.

6 Results

6.1 Compustat Data from Financial Filings

The framework of the analysis presented here is similar to earlier studies, including Hall (1994). As a baseline, my best effort to replicate the relevant Hall results and reconcile them with my own estimates is presented in Table 2.7. Hall used instrumental variables for several reasons: first, the simultaneity of her regressors with the firm's future R&D expenditure path; second, measurement error in the tax price due to the inaccuracy of using financial data to calculate tax prices; third, measurement error due differences between the tax price as forecasted by the firm when making its spending decisions and observed by the econometrician. To address these issues she instruments for all right hand side variables with the regressors lagged two and three times as well as with lagged tax status and lagged growth rates in R&D and sales. Column 1 of Table 2.7 reports the results of my attempt to replicate the results in column 4 of Table 2.6 in Hall (1994), which corresponds to the first-differenced log-log specification.

Column 2 instruments with lagged right-hand side variables and uses data from the entire decade after 1981 but includes non-manufacturing firms; the addition of these firms does not significantly affect the estimated tax-price elasticity. Years where the parameters of the R&D tax credit remained unchanged are dropped in column 3's specification as my instrumenting strategy relies on tax changes. Again limiting the sample to 1982 and 1986-1990 does not dramatically affect the estimated elasticity. Column 4 uses the synthetic tax-price instruments, which are described in detail in Section 3. These instruments, which are more plausibly exogenous than the instruments used in columns 1-3, reduce the tax-price elasticity estimate by nearly fifty percent. Because the change in sales, which is included as a control in equation 13 could conceivably be endogenous, column 5 reports the results from a model that does not include contemporaneous or lagged sales as a regressor. Dropping the log-change in sales has no impact on the estimate.

The IV regression of equation 13 might itself be biased if ϵ_{it} and R_{it-1} are correlated. Mean reversion, for example, would lead to a negative correlation between the error term and R&D spending the previous year. If ϵ_{it} and R_{it-1} are correlated then the instrument will be also be correlated with the error term since the instrument is constructed using spending last period. Like Auten and Carroll (1999), and Gruber and Saez (2002) last period spending, $\log R_{it-1}$, is added as a control. Because changes in the R&D tax credit may affect any relationship between current and last period spending, these controls are allowed to vary by year as a robustness check (see column 2 of Table 2.8). Of course including a control for the lag dependent variable in a differenced model leads to a biased estimator in finite samples. I instrument for lag spending as suggested by Hausman, Hahn and Kuersteiner (2001) using further lags. The results of this regression are reported in column 6 of Table 2.7. Again the inclusion of these further controls does not change the estimated elasticity.

To investigate the sensitivity of the relationship between R&D spending and its user-cost to alternative specifications a series of robustness checks were conducted; the results are presented in Table 2.8. The baseline specification from column 6 of Table 2.7, which instruments for the endogenous tax-price with the synthetic tax-adjustment factor and includes controls for the logs of lag R&D spending and lag sales, is reported in column 1 to facilitate comparisons. As described above, because changes in tax policy may affect the underlying relationship between current and lag R&D spending, for example if more generous tax treatment leads to the undertaking of new projects that require many years of funding, column 2 interacts the lag spending terms with year fixed effects. Allowing the effect of $\log R_{it-1}$, to vary from year to year has virtually no impact on the user-cost elasticity estimate. Columns 3 and 4 control for industry specific factors. Neither industry fixed effects, column 3, nor linear industry time trends, column 4, appreciably impact the elasticity estimate. Because only firms with material R&D expenditures must report their R&D expenditures in financial filings, the data are censored by a firm-specific threshold. Column 5 reports estimates from a specification that includes a control function to correct for selection; identification is from functional form. Correcting for selection reduces the magnitude of the point estimate by a statistically insignificant 1.2 percentage points. Column 6 assess the impact of selective reporting by limiting the sample to only those firms that report R&D spending in all years. The estimated elasticity is roughly 1.7 percentage points larger, but again the difference is statistically insignificant. Firms end their fiscal years in all months of the year; tax policy is largely tied to the calendar year. Tax-price variables are likely to be mis-measured for firms whose fiscal years do not coincide with the calendar year. To assess the impact of this mis-measurement the model is estimated using only firms with December fiscal year ends. As column 7 reports, the point estimate is statistically indistinguishable from the baseline estimate.

The log-log specification includes only observations with non-zero R&D expenditures. In the Compustat data this does not necessitate dropping many firms, in fact only 40 firm-year observations have zero R&D expenses but report all other necessary data, including previous spending, to be included in a regression of the form of Column 4 of Table 2.6. In other words, if a firm ever reports R&D expenses in its SEC filings, it does so in every year and once it engages in material R&D it continues to do so. The log-log specification is less appropriate for analysis of the IRS data. Firms only report the specifics of their R&D spending and credit status in years they claim the credit; if a firm does not qualify for a R&D tax credit it likely does not file a form 6765 and it does not disclose the details of its research activities.

The IRS data in short has many more zeros than the Compustat data. Though a firm that does not file a 6765 form likely has non-zero research expenditures, in the main analysis using only the IRS data these observations are treated as the appear in the data as zeros. The appropriateness of this treatment is assessed in later analysis that uses both Compustat and IRS data. To retain observations with zero spending but also scale for disparate firm size in the remaining analysis the dependent variable of regression equation 13 is replaced with the change in R&D spending divided by first lag of sales. Sales is a natural choice for the scaling variable since research-intensity, the ratio of R&D to Sales, has been an outcome of interest in previous research including (Griliches (1984)) and is used as a benchmark, the fixed base percentage, in the formula for the R&D credit as well.

The regressions reported in Tables 2.9-2.12 are of the basic form:

$$\left[\frac{R_{it} - R_{it-1}}{S_{it-1}}\right] = \alpha + \sigma\left[\lambda_{it} - \lambda_{it-1}\right] + \eta\left[\frac{S_{it} - S_{it-1}}{S_{it-1}}\right] + \gamma R_{it-1} + \chi_t + \epsilon_{it} \tag{14}$$

Table 2.9 reports the results of regressions of the above form using only Compustat data. Column 1 reports the OLS results, which suggest that a ten percent decrease in the tax component of the user cost of R&D would increase the average firm's R&D-to-lagged-Sales ratio by 4.3 percent. Adding flexible time controls, as in column 2, does not affect the estimated coefficients. Because a firm's credit rate is a function of its R&D spending column 3 instruments for the firm's tax component to disentangle this simultaneity. As described earlier, the instrument is constructed using the first lag of R&D spending, which must be controlled for in the regression. Because the first lag of R&D spending is also a lagged dependent variable, it must also be instrumented for with other lags.[13] Instrumenting for both the endogenous tax component and the first lag of R&D expenditures shrinks the point estimate from -0.045 (0.01) to -0.035 (0.008), a statistically insignificant reduction in magnitude. The estimates reported in column 3 imply that a ten percent decrease in the

[13]Here the third lag of R&D spending is used, but the results are invariant to instrumenting with other lags.

user cost, or a 9.36 percent subsidy, would result in a 3.56 percent increase in the average firm's R&D intensity. In other words, if sales levels remained unchanged, the average firm's R&D expenditures would increase by roughly $10.7 million. The estimates from column 4 of Table 2.8 suggest that a ten percent decrease in the usercost would result in a $3.5 million increase in R&D spending; the specification differences lead to somewhat different answers. Estimating the specification of column 3 of Table 2.9 on the 6,339 observations from the sample of column 4 of Table 2.7 that have sufficient data, yields a coefficient of -0.036 (0.008)—almost identical to the estimates reported in column 3 of Table 2.8.[14] It is not the difference in selection resulting from dropping the zero spending firms that drives the difference in elasticity estimates but the difference in specification. Different specifications clearly yield different estimates of the impact of tax subsidies on R&D spending. Though the estimates are robust within a class of specifications, as illustrated by Table 2.8 for the log-log specification, using R&D intensity as the outcome of interest triples the implied effect of a ten percent reduction in usercost.

6.2 IRS SOI Data

Table 2.10 reports the results of regressions of the basic form of equation 14 but uses only IRS data. While providing unbiased measures of the subsidies to qualified R&D spending, the IRS data does not describe total R&D spending by firms. The IRS data come from the research credit form, Form 6765, and describe only qualified research expenditures, in other words only the spending to which the credit applies. Though using IRS data alone cannot capture how tax subsidies affect total R&D spending, they can describe how subsidized R&D spending responds to its subsidy. OLS estimates reported in columns 1 and 2 of Table 2.10 suggest that a ten percent decrease in the user cost of R&D would result in approximately $3.8 million in additional qualified research spending by the average firm.

[14] Estimating the specification of column 4 of Table 2.6 using just the 6,171 observations that have sufficient data for both specifications yields an elasticity of -0.461 (0.032), virtually identical to the estimate reported in column 4 of Table 2.6.

Column 1 includes only the listed regressors while column 2 also includes year fixed effects. Instrumenting for the tax factor, however, halves the estimate, suggesting a ten percent reduction in user cost only increases average qualified research spending by $2 million. The average firm in the sample reports roughly $8 million in QREs; among firms with non-zero QREs average qualified spending is $27.5 million. Although the coefficient estimates in Table 2.10 are similar in magnitude to those of Table 2.9, because qualified research expenditures (QREs) comprise less than forty percent of total R&D expenditures, the implied elasticities of Table 2.10 are much larger than those of Table 2.9.[15] The fully instrumented specifications have standard errors too large to make precise comparisons, but the point estimates of the two tables suggest that qualified research spending is more elastic that total R&D. These comparisons should also be caveated by the fact that the regressions in Table 2.9 make use of an inaccurate measure of the tax component of the usercost.

IRS data report as many as five categories of QREs. Using the same regression specification as column 3 of Table 2.10, but replacing total QREs with each component of spending, the impact of tax subsidies on different types of qualified research spending is reported in Table 2.11. Qualified spending broken down by category was unavailable for 1990, so the number of observations reporting R&D spending on wages and salaries, supplies, equipment rental, and contracted research is only 14,394 rather than 18.691 as in column 3 of Table 2.10. Data regarding research payments to universities and other eligible nonprofit organizations for the conduct of basic research were not reliably available after 1986, hence only one year of data is included in the column 5 regression. Interestingly, changes in usercost only significantly impact wages and salaries and supplies, columns 1 and 2 respectively. Wages and salaries and supplies, comprising 66.6 and 19.2 percent of qualified R&D respectively, are the two largest categories of research spending. Although contracted research accounts for 11.6 percent of QREs, usercost does not appreciably affect contracted research spending as shown in column 4.

[15]Qualified R&D comprises 39 percent of total R&D for the subsample of 953 firms found in both data sets that report both measures of research expenditures.

The elasticities reported in Tables 2.10 and 2.11 show that qualified research spending is responsive to tax-based subsidies. The magnitude of the elasticity is larger than that of total spending as measured in the Compustat data and reported in Table 2.9, suggesting that the portion of research that the credit is applied to is more measurably responsive than overall spending. It is notable that the same choice of instruments that reduced the elasticity estimated in the public data still yields a large elasticity estimate for qualified research. The different impacts of different choices of instruments, specifications and research spending measures make it difficult to draw strong comparative conclusions, but highlight the fact that estimates of the elasticity of R&D spending with respect to the tax-price are sensitive to these choices.

6.3 Merged Sample of Compustat and IRS SOI Data

By merging the Compustat and SOI samples the impact of tax subsidies on total and qualified R&D spending can accurately be assessed using a common sample as described in Section 4. Because the SOI data is a sample of firms that includes both public and private firms, and more important because only a fraction of firms report R&D spending in their financial filing or file for the R&D tax credit, only 953 observations can be matched between the two data sets. The instrumenting strategy I employ, which requires multiple lagged values of R&D spending as well as other data, further reduces the sample. Table 2.12 presents estimates from regressions identical to those of Table 2.11 but restricted to this merged sample. IRS data is used to construct the tax factor for all four columns of estimates. Columns 1 and 2 and describe the impact of changes in the tax factor on total R&D spending while columns 3 and 4 describe the impact on qualified spending. Interestingly, for both the OLS and IV specifications changes in user cost have no statistically discernible impact on total R&D spending, despite the relatively small standard errors. Estimating the specification of Column 3 of Table 2.9, which is identical to column 2 of Table 2.12 except the user cost measures are based on Compustat rather than the more accurate IRS data, on the sample of roughly 200 merged firm-years yields a coefficient estimate of -0.058 (0.028)—a statistically significant estimate similar to those of Table 2.7. This suggests that the mis-measurement of the tax subsidy in Table 2.8 may play a role in generating statistically significant estimates that are not apparent when the correct tax subsidy measure is used as in Table 2.12.

Columns 3 and 4 of Table 2.12 report estimates for the impact of changes in the user cost on qualified research expenditures. Again, much like Table 2.10, usercost decreases result in statistically significant increases in R&D spending according to both the OLS and IV specifications. The results reported in columns 2 and 4 suggest that when the correct measure of the tax-adjustment factor is used, only qualified research spending is significantly affected by tax subsidy for qualified spending. Total R&D expenditures include other forms of spending, such as R&D conducted abroad or by subsidiaries unconsolidated for tax purposes or R&D that is not deemed experimental or technological enough, that make it difficult to discern the impact of the tax subsidy on total R&D spending. It is important to note that these different measured impacts come from a very small sample. Because the merged sample is so small, the pattern of these estimates is more suggestive than definitive. They do show, however, that the estimated impact of tax subsidies for R&D is sensitive to the choice of spending measure.

7 Conclusion

This paper uses public data from financial filings and new restricted-access data from tax returns to assess the impact of tax credits on R&D expenditure decisions. An instrumental variables strategy that relies on tax policy changes disentangles the simultaneity of incremental credit rates and R&D spending. The empirical findings demonstrate that tax-price elasticity estimates for R&D are sensitive to choices of instruments, specifications and spending measures. Estimates using only publicly available data suggest that a ten percent tax subsidy for R&D yields between \$3.5 (0.24) million and \$10.7 (1.79) million in new R&D

spending. Estimates from IRS SOI data, which only reports qualified research expenditures, suggest that a ten percent reduction in the usercost would lead firms to increase qualified spending by $2 .0 (0.39) million. Analysis of the components of qualified research spending shows that wages and supplies, which comprise the bulk of qualified spending, account for the increase in research spending. These estimates come from different samples and use different data to construct measures of the tax component of the usercost of R&D. Estimates from the much smaller merged sample which makes use of the more precise tax data to calculate the tax component of the usercost suggest that qualified spending is responsive to the tax subsidy. A similar response in total spending is not statistically discernible in the merged sample.

These disparate and inconsistent results from different data samples illustrate the sensitivity of estimates of the tax-price elasticity of R&D to choices of instrumental variables, specifications and spending measures. Rather than yielding a single, consistent, number for the elasticity, the various analyses presented here instead show that estimates of the tax price elasticity are not robust across datasets and methods. Nonetheless, some conclusions can be drawn. First, there is considerable evidence that qualified research spending—the exact research efforts that are subsidized by the tax credit—is responsive to the reductions in the usercost due to the R&D credit. Second, comparisons between Compustat and SOI data show that relying on the public data results in significant mis-measurement of the tax-adjustment factor of the usercost. Third, non-qualified research spending is a significant fraction of total research spending as reported in financial filings, averaging more than 60 percent, and is a potentially important margin of adjustment when firms increase research spending in light of tax subsidies.

The empirical findings reported here bear on short-run research spending decisions, and there are several important considerations regarding broader interpretations. First, longer run impacts may differ from the short-run response investigated here. Long-run elasticities may exceed the one-year response if changes in research spending incur adjustment costs.

Long-run elasticities could conceivably be smaller than the one-year response if firm's react to changes in their effective R&D tax subsidies by simply retiming research spending to maximize their credits. Second, the analysis here uses changes in the provisions of the research credit from the 1980s to identify the user-cost elasticity; research patterns from up to 30 years ago may not represent current R&D patterns in terms of shares of spending by firms in different industries, of different sizes, etc. Third, throughout the analysis firms' expectations of the future of the R&D tax credit are ignored. During its first decade the R&D credit was always renewed before it expired. Since then the credit has been allowed to lapse several times, most of the time being put into place retroactively, but on one occasion the credit was simply allowed to expire for a year. In the current, less predictable environment, firms' expectations regarding the future of the R&D credit likely impact how they react to the subsidy while it is in place. Estimates from an era of greater certainty may not be fully applicable today.

The inconsistency of estimates across the datasets and specifications make clear that further work is needed to assess the impact of tax subsidies on R&D spending. Larger datasets that allow for accurate measurement of the tax subsidy each firm faces and broad measures of R&D spending would allow researchers to better assess how non-qualified research spending reacts to subsidies for qualified spending. While it may be worthwhile to incentivize firms to direct nonqualified spending toward activities that qualify for the credit, if the increase in qualified spending reported here comes largely at the cost of nonqualified spending, the effect of the policy has a very different interpretation than if the increase in qualified spending was new research dollars. The degree to which spending is being redirected to qualified research is an important open question for future work. The question of relabeling has also drawn attention in policy circles. If firms are not even redirecting research, but just relabeling activities as qualified activities, the policy would be ineffective. Perhaps assessments of how IRS audit outcomes change with subsidy rates could help shed some light on how the R&D tax credit creates incentives for relabeling. These are issues I would like to pursue in future work.

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Table 1: Legislative History of the Research and Experimentation Credit

	Credit Rate*	Corporate Tax Rate	Definition of Base	Qualified Research Expenditures	Sec. 174 deduction**	Foreign Allocation Rules	Carryback/Carryforward
July 1981 to Dec 1981	25%	48%	Maximum of previous 3-year average or 50% or current year	Excluded: research performed outside US; humanities and soc. science research; research funded by others	None	100% deduction against domestic income	3 years/15 years
Jan 1982 to Dec 1985	Same	46%	Same	Same	Same	Same	Same
Jan 1986 to Dec 1986	20%	34%	Same	Definition narrowed to technological research. Excluded leasing	Same	Same	Same
Jan 1987 to Dec 1987	Same	Same	Same	Same	Same	50% deduction against domestic income; 50% allocation	Same
Jan 1988 to Apr 1988	Same	Same	Same	Same	Same	64% deduction against domestic income; 36% allocation	Same
May 1988 to Dec 1988	Same	Same	Same	Same	Same	30% deduction against domestic income; 70% allocation	Same
Jan 1989 to Dec 1989	Same	Same	Same	Same	-50% credit	64% deduction against domestic income; 36% allocation	Same
Jan 1990 to Dec 1991	Same	Same	1984-1988 R&D to sales ratio times current sales (max of 16%); 3% of current sales for startups	Same	-100% credit	Same	Same
Jan 1992 to Dec 1993	Same	Same	Startup rules modified	Same	Same	Same	Same
Jan 1994 to June 1995	Same	35%	Same	Same	Same	50% deduction against domestic income; 50% allocation	Same
July 1995 to June 1996	0%	Same	None	-	-	Same	Same
July 1996 to June 1999	20%	Same	1984-1988 R&D to sales ratio times current sales (max of 16%); 3% of current sales for startups	Same as before lapse	-100% credit	50% deduction against domestic income; 50% allocation	Same
July 1999 to June 2004	Same	Same	Also includes research undertaken in Puerto Rico and U.S. posessions.	Same	Same	Same	Same
July 2004 to Dec 2005	Same	Same	Same	Same	Same	Same	Same
Jan 2006 to Dec 2007	Same	Same	Same	Transition rules altered slightly and alternative credits modified as outlined on next sheet.	Same	Same	Same

* In all years the firm can apply the credit rate to 50% of current QREs if the base amount is less than 50% of current QREs.

** Section 174 of the IRC provides an immediate deduction for most research and experimentation expenditures. Taxpayers can also elect to amortize these expenditures over 60 months, but in practice most firms immediately expense R&D. However, the IRC does not define what qualifies as R&D expenditures. Treasury regulations have generally interpreted them to mean "R&D costs in the experimental or laboratory sense."

Note: Based on Hall (1994), the Senate Budget Committee's 2006 Tax Expenditures compendium and Thomas legislative summaries.

Table 2: Distribution of Firms by Qualified Share of Total R&D Expenditures, Merged Sample of Compustat and IRS SOI Data

	Observations	0	0.00-0.20	0.20-0.40	0.40-0.60	0.60-0.80	0.80-0.90	≥ 0.90
1981	61	0.279	0.148	0.262	0.164	0.049	0.016	0.082
1982	70	0.343	0.014	0.057	0.186	0.200	0.029	0.171
1983	76	0.263	0.013	0.026	0.224	0.224	0.092	0.158
1984	75	0.360	0.013	0.053	0.227	0.213	0.040	0.093
1985	43	0.419	0.000	0.093	0.140	0.209	0.047	0.093
1986	75	0.533	0.013	0.013	0.147	0.160	0.040	0.093
1987	65	0.538	0.000	0.077	0.123	0.154	0.031	0.077
1988	61	0.525	0.000	0.082	0.098	0.131	0.016	0.148
1989	64	0.563	0.016	0.078	0.156	0.063	0.016	0.109
1990	59	0.458	0.017	0.102	0.169	0.119	0.017	0.119
1991	57	0.544	0.018	0.105	0.123	0.070	0.000	0.140
Total	706	0.435	0.023	0.082	0.163	0.147	0.033	0.118

Note: The above shares are the ratio of qualified research expenditures (QREs) as reported in the firm's corporate tax return to the firm's total R&D expenditures as reported in its financial filings. The firm's research credit and marginal research credit rate are determined by QREs. Total research expenditures as reported in financial statements includes foreign research spending and expenditures that do not satisfy the experimental and technological requirements of the R&D credit. The sample consists of all firms that can be successfully merged by Employer Identification Number between the Compustat and IRS datasets and report enough data to be included in later regression analysis.

Table 3: Average User Costs, Credit Recipiency Rates and Shares With Negative Credit Rates by Year, Compustat and IRS SOI Data

		Compustat Data				IRS SOI Data			
		Observations	User Cost (Tax Price Component)	Fraction Receiving R&D Tax Credit	Fraction with Negative Marginal Credit Rates	Observations	User Cost (Tax Price Component)	Fraction Receiving R&D Tax Credit	Fraction with Negative Marginal Credit Rates
Regime 1: Statutory rate of 25% and expensing, clawback	1981	1,537	0.884	0.657	0.149	6,300	0.914	0.521	0.241
	1982	1,371	0.907	0.636	0.182	6,056	0.849	0.540	0.083
	1983	1,239	0.921	0.621	0.215	6,209	0.869	0.480	0.087
	1984	1,238	0.906	0.613	0.191	6,166	0.878	0.441	0.076
	1985	1,304	0.904	0.604	0.194	3,929	0.906	0.376	0.080
Regime 2: Statutory rate of 20% and expensing, clawback	1986	1,317	0.942	0.568	0.209	6,048	0.940	0.329	0.086
	1987	1,347	0.957	0.532	0.220	5,964	0.947	0.289	0.076
	1988	1,466	0.933	0.564	0.158	5,789	0.949	0.299	0.076
Regime 3: Statutory rate of 20% OR expensing, clawback	1989	1,538	0.923	0.577	0.114	5,601	0.955	0.309	0.050
Regime 4: Statutory rate of 20% or expensing, NO clawback	1990	1,821	0.918	0.459	0.000	5,467	0.961	0.283	0.000
	1991	1,831	0.926	0.419	0.000	4,759	0.958	0.248	0.000
Overall		16,009	0.920	0.561	0.138	62,288	0.919	0.379	0.081

Note: Samples consist of all firm-year observations that report sufficient data to be included in later regression analysis. The tax component of the user cost formula, labelled λ_t in the text, takes both expensing provisions and the research credit into account, in addition to reflecting any losses that reduces the value of tax advantages. In the Compustat sample firms receiving R&D tax credits are all firms that report current year R&D expenses that exceeed their calculated base amounts. In the IRS sample all firms who report a tentative R&D tax credit are considered credit recipeints. Negative marginal credit rates arose for firms prior to the revamping of the credit in 1990 when they failed to qualify for a credit in the current year but their current year spending increased base amounts for the subsequent three years when they did qualify for the credit.

Table 4: Average User Costs, Credit Recipiency Rates and Shares With Negative Credit Rates by Year, Merged Sample of Compustat and IRS SOI Data

			Compustat Data			IRS Data		
	Year	Observations	User Cost (Tax Price Component)	Fraction Receiving R&D Tax Credit	Fraction with Negative Marginal Credit Rates	User Cost (Tax Price Component)	Fraction Receiving R&D Tax Credit	Fraction with Negative Marginal Credit Rates
Regime 1: Statutory rate of 25% and expensing, clawback	1981	67	0.880	0.821	0.104	1.025	0.657	0.433
	1982	60	0.942	0.733	0.167	0.888	0.600	0.150
	1983	58	0.945	0.759	0.224	0.864	0.638	0.138
	1984	49	0.974	0.694	0.245	0.883	0.571	0.163
	1985	31	0.980	0.677	0.226	0.919	0.516	0.161
Regime 2: Statutory rate of 20% and expensing, clawback	1986	53	0.957	0.698	0.094	0.935	0.509	0.132
	1987	45	1.000	0.622	0.289	0.926	0.422	0.133
	1988	45	0.951	0.711	0.178	0.916	0.489	0.111
Regime 3: Statutory rate of 20% OR expensing, clawback	1989	45	0.944	0.667	0.178	0.940	0.444	0.067
Regime 4: Statutory rate of 20% or expensing, NO clawback	1990	51	0.876	0.667	0.000	0.937	0.451	0.000
	1991	49	0.902	0.551	0.000	0.929	0.388	0.000
Overall		553	0.937	0.698	0.150	0.926	0.526	0.145

Note: The sample consists of all firms that can be successfully merged by Employer Identification Number between the Compustat and IRS datasets and report enough data to be included in later regression analysis. The tax component of the user cost formula, labelled λ_t in the text, takes both expensing provisions and the research credit into account, in addition to reflecting any losses that reduces the value of tax advantages. In the Compustat sample firms receiving R&D tax credits are all firms that report current year R&D expenses that exceeed their calculated base amounts. In the IRS sample all firms who report a tentative R&D tax credit are considered credit recipeints. Negative marginal credit rates arose for firms prior to the revamping of the credit in 1990 when they failed to qualify for a credit in the current year but their current year spending increased base amounts for the subsequent three years when they did qualify for the credit.

Table 5: Distribution of Firms by Tax Component of User Cost, Merged Sample of Compustat and IRS SOI Data

	Observations	< 0.75	0.75-0.80	0.80-0.875	0.875-0.95	0.95-1.00	1.00-1.25	≥ 1.25
1981	6,300	0.099	0.313	0.134	0.131	0.076	0.136	0.111
1982	6,056	0.167	0.270	0.170	0.105	0.152	0.125	0.011
1983	6,209	0.172	0.200	0.151	0.094	0.191	0.178	0.015
1984	6,166	0.188	0.155	0.122	0.061	0.214	0.244	0.016
1985	3,929	0.154	0.116	0.107	0.054	0.232	0.320	0.018
1986	6,048	0.108	0.021	0.142	0.081	0.282	0.357	0.009
1987	5,922	0.059	0.054	0.113	0.128	0.092	0.553	0.002
1988	5,789	0.056	0.056	0.115	0.123	0.236	0.410	0.003
1989	5,601	0.065	0.032	0.079	0.152	0.280	0.392	0.000
1990	5,465	0.000	0.000	0.043	0.314	0.265	0.378	0.000
1991	4,756	0.000	0.000	0.158	0.102	0.300	0.440	0.000
Total	62,241	0.0989	0.1157	0.1222	0.1228	0.2068	0.3158	0.0177

Note: The sample consists of all firm-year observations from the Compustat dataset that report sufficient data to be included in later regression analysis. The tax component of the user cost formula, labelled λt in the text, takes both expensing provisions and the research credit into account, in addition to reflecting any losses that reduces the value of tax advantages. Research credit rates are calculated using total R&D spending as reported in firm financial statements.

Table 6: Comparison of Average Actual and Synthetic User Cost Tax-Adjustment Factors, Compustat and IRS SOI Data

		Compustat Data			IRS Data		
	Year	Observations	Actual User Cost Tax-Adjustment Factor	Synthetic User Cost Tax-Adjustment Factor	Observations	Actual User Cost Tax-Adjustment Factor	Synthetic User Cost Tax-Adjustment Factor
	1981	1,520	0.882	0.765	-	-	-
	1982	1,371	0.907	0.792	5,529	0.855	0.885
Regime 1: Statutory rate of 25% and expensing, clawback	1983	1,239	0.921	0.817	5,519	0.875	0.868
	1984	1,238	0.906	0.841	5,251	0.886	0.868
	1985	1,304	0.904	0.846	3,747	0.906	0.865
	1986	1,317	0.942	1.002	3,501	0.951	0.885
Regime 2: Statutory rate of 20% and expensing, clawback	1987	1,347	0.957	1.013	5,277	0.952	0.888
	1988	1,466	0.933	0.926	5,249	0.953	0.897
Regime 3: Statutory rate of 20% OR expensing, clawback	1989	1,538	0.923	0.940	5,184	0.957	0.913
Regime 4: Statutory rate of 20% or expensing, NO clawback	1990	1,692	0.916	0.899	5,030	0.962	0.903
	1991	1,699	0.923	0.901	4,488	0.959	0.902
Overall		15,731	0.919	0.886	48,775	0.924	0.888

Note: Actual user cost tax-adjustment factors reflect both prevailing expensing and research credit provisions and contemporaneous research spending. Research credit rates are calcultated using contemporaneous total R&D spending in the case of Compustat data and qualified research expenditures in the case of IRS SOI data. Synthetic user cost tax-adjustment factors are constructed using prevailing expensing and research credit provisions, but the first lag of research spending (total R&D spending in Compustat data and QREs in the IRS SOI data).

Table 7: Tax-Price Elasticity Estimates Using Compustat Data and Different Instrument Sets

IV:	Lag RHS Vars	Lag RHS Vars	Lag RHS Vars	Synthetic IVs	Synthetic IVs	Synthetic IVs
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(\rho_{it} / \rho_{t-1})$	-0.844	-0.822	-0.734	-0.449	-0.466	-0.453
	(0.097)	(0.088)	(0.100)	(0.035)	(0.032)	(0.031)
$\log R_{it-1}$	0.003	0.002	-0.001	-0.035	-0.002	-0.042
	(0.006)	(0.004)	(0.006)	(0.007)	(0.002)	(0.007)
$\log(S_{it} / S_{it-1})$	-0.006	-0.004	-2.47E-04	0.007	-	0.042
	(0.007)	(0.005)	(0.007)	(0.009)	-	(0.007)
Years	1981-1991	1981-1991	1982, 1986-90	1982, 1986-90	1982, 1986-90	1982, 1986-90
Industry	Manufacturing	All	All	All	All	All
Observations	5,615	6,398	3,131	6,339	6,248	6,207

Note: The specification in column 1 corresponds to my best effort to replicate the results of an earlier study, Hall (1994). That specification instrumented for all three regressors with their second and third lags as well as with lagged tax status and lagged growth rates in R&D and sales. It limited the analysis to only manufacturing firms but included observations from all years between 1981 and 1991. The instrumenting strategy based on synthetic tax-adjustment user cost factors, used in columns 4-7, is laid out in Section 2.2 and is only valid in years where the provisions of the tax credit were altered. The basic specification of columns 4-7 is:

$$\log\left(\frac{R_{it}}{R_{it-1}}\right) = \sigma \log\left(\frac{\lambda_{it}}{\lambda_{it-1}}\right) + \chi_t + \eta \log\left(\frac{Y_{it}}{Y_{it-1}}\right) + \varepsilon_{it}$$

These regressions include all firms, though the vast majority are manufacturing firms. Column includes the log growth in sales as a control as well as lag R&D spending. Lag R&D is included because the synthetic instruments are only exogenous conditional on the lag of R&D which was used in constructing the instruments. Column 5 resestimates the specification of column 4 dropping the control for log sales growth. Column 6 instruments for the potentially endogenous lag of R&D. All regressions include year fixed effects and a constant. Standard errors are clustered at the two-digit industry level; there are 20, 48, 46 clusters in columns 1-3, respectively and 52 clusters for columns 4-6.

Table 8: Tax-Price Elasticity Estimates Using Compustat Data, Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\log(\rho_{it}/\rho_{t-1})$	-0.453	-0.44	-0.401	-0.400	-0.441	-0.470	-0.460
	(0.031)	(0.057)	(0.057)	(0.058)	(0.067)	(0.038)	(0.065)
Year-specific $\log R_{it}$		X					
Industry FE			X				
Industry time trend				X			
Control function					X		
Reports in all years						X	
December FY end							X
Observations	6,207	6,207	6,207	6,207	6,207	3,360	3,305

Note: The specification in column 1 is the baseline estimate and corresponds to column 6 of Table 1.7. The log-change in the tax-adjustment factor, $\log(\rho_{it}/\rho_{t-1})$, is the instrumented with the synthetic change in the tax-adjustment factor, as explained in Section 1.2.2. The specification of column 1 is:

$$\log\left(\frac{R_{it}}{R_{it-1}}\right) = \sigma \log\left(\frac{\lambda_{it}}{\lambda_{it-1}}\right) + \chi_t + \eta \log\left(\frac{Y_{it}}{Y_{it-1}}\right) + \varepsilon_{it}$$

where χ_{it} includes year fixed effects and the first lag of log R&D spending, $\log R_{it}$. Additional terms are included in the specifications corresponding to columns 2 through 6. Column 2 adds a cubic in $\log R_{it-1}$ for each year. Column 3includes industry fixed effects and column 4 further adds a linear time trend for each NAICS two-digit industry. Column 5 adds a control function to corrects for selection. Column 6 limits the sample to only firms that report data for all five years. Column 7 limits the sample to firms with December fiscal year ends. All regressions also include a constant. Standard errors are clustered at the two-digit NAICS industry level.

Table 9: Impact on Total R&D Spending (COMPUSTAT Data Only)
Dependent Variable: (Δ Total R&D Exp./$Sales_{t-1}$)

	OLS (1)	OLS (2)	IV (3)
Δ Tax Part of Usercost	-0.043	-0.045	-0.035
	(0.010)	(0.011)	(0.007)
Sales Growth	2.28E-02	2.40E-02	0.021
	(1.25E-02)	(1.24E-02)	(0.013)
First Lag Total R&D	-	-	3.24E-07
			(8.72E-07)
Usercost Elasticity	-0.436	-0.453	-0.356
	(0.101)	(0.104)	(0.078)
Impact of a 10% decrease in usercost in $M R&D	13.182	13.705	10.749
	(3.059)	(3.145)	(1.787)
Observations	7,767	7,767	7,631

Note: All regressions include a constant. All data are inflated using the GDP index. Standard errors are clustered at the two-digit industry level according to NAICS codes from Compustat; these data span 59 industries.

Table 10: Impact on Qualified R&D Spending (IRS Data Only)
Dependent Variable: (Δ Qualified R&D/$Sales_{t-1}$)

	OLS (1)	OLS (2)	IV (3)
Δ Tax Part of Usercost	-0.046	-0.045	-0.024
	(0.007)	(0.007)	(0.005)
Sales Growth	0.026	0.026	0.029
	(0.011)	(0.011)	(0.014)
First Lag Qualified R&D	-	-	7.93E-07
			(1.61E-06)
Usercost Elasticity	-3.424	-3.316	-1.673
	(0.522)	(0.503)	(0.332)
Impact of a 10% decrease in usercost in $M R&D	3.836	3.715	1.960
	(0.585)	(0.564)	(0.389)
Observations	28,371	28,371	18,691

Note: All regressions include a constant. All data converted to real dollars using the GDP index. Standard errors clustered at the two-digit industry level according to SOI industry codes; these data span 69 industries.

Table 11: Impact on Qualified R&D Spending Components (IRS Data Only)

Dependent Variable: (Δ Qualified R&D/Sales$_{t-1}$)

	Wages & Salaries (1)	Supplies (2)	Equipment (3)	Contracted (4)	University (5)
Δ Tax Part of Usercost	-0.016	-0.005	-5.42E-04	-9.11E-04	-9.67E-04
	(0.004)	(0.001)	(4.78E-04)	(9.49E-04)	(6.09E-04)
First Lag Total QRE	5.34E-07	-3.13E-07	-1.14E-07	8.96E-07	1.66E-07
	(1.10E-02)	(5.12E-07)	(1.42E-02)	(3.52E-07)	(2.58E-07)
Sales Growth	0.025	0.005	0.000	0.002	1.99E-05
	(0.013)	(0.003)	(0.000)	(0.001)	(1.48E-05)
Usercost Elasticity	-1.655	-1.926	-6.300	-1.069	1.17E-04
	(0.449)	(0.454)	(5.560)	(1.111)	(1.15E-04)
Impact of a 10% decrease in usercost in $M R&D	1.431	0.417	0.049	0.083	0.088
	(0.389)	(0.098)	(0.044)	(0.087)	(0.056)
Observations	14,394	14,394	14,394	14,394	2,882

Note: All regressions include a constant. All data converted to real dollars using the GDP index. Standard errors clustered at the two-digit industry level according to SOI industry codes; these data span 69 industries.

Table 12: Impact on Total R&D Spending (Merged Data)				
Dependent Variable:	(Δ Total R&D Exp./Sales$_{t-1}$)		(Δ Qualified R&D/Sales$_{t-1}$)	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
Δ Tax Part of Usercost	-0.002	-0.015	-0.047	-0.093
	(0.010)	(0.011)	(0.014)	(0.042)
Sales growth	-0.003	-0.002	0.027	0.022
	(0.001)	(0.001)	(0.013)	(0.020)
First Lag Total R&D	-	1.47E-05	-	-4.11E-06
		(1.24E-05)		(1.47E-05)
Usercost Elasticity	-0.043	-0.315	-2.330	-5.940
	0.211	0.254	(0.700)	(2.435)
Impact of a 10% decrease in usercost in $M R&D	-0.330	2.168	8.156	16.260
	(1.614)	(1.743)	(2.451)	(7.182)
Observations	314	217	314	216

Note: All regressions include a constant. All data are inflated using the GDP index. Standard errors are clustered at the two-digit industry level according to NAICS codes from Compustat; these data span 59 industries. No observations from 1986 were found in both samples with sufficient lag and leading data for the IV specification.

Appendix

Several variables used to calculate a firm's marginal R&D tax credit rate are not reported directly and must instead be inferred from other variables. These variables, and their instrument analogue were calculated as follows:

j_{it}: the number of years the firm will carry forward any earned R&D tax credits

If a firm does not pay federal taxes, it is assumed to not have taxable income and must therefore carry-back (then carry-forward) its R&D tax credit. The R&D tax credit can be carried back up to 3 years and carried forward up to 15 years. The analysis presented here only calculates up to 6 carry-forward years; firms who would carry the credit forward more than 6 years are assigned a six-year carry-forward period. The firm will first offset taxes paid (Compustat Data63) three years prior. If its taxes paid three years prior are insufficient to offset the credit, it will offset taxes paid two years prior, then one year prior. Any remaining R&D tax credit will then be carried forward.

To construct the synthetic tax rate, j_{it} is replaced by a constant (0.5) for all firms in all years.

k_{it}: the number of years until any tax losses will be exhausted

Compustat reports a firm's stock of net operating loss carry-forwards (Data 52) but not their time to expiration. Net operating losses (NOLs) can be carried forward up to 20 years. All NOL carry-forwards are assumed to be used before they expire. NOLs are first used to offset the following year's pre-tax income (Data272). If next year's pre-tax income is insufficient to offset all NOL carry-forwards, the remaining NOL carry-forwards are offset against the second leading year's pre-tax income and so on. The analysis presented here only calculates up six years of tax losses; firm who may have more than six years of tax losses are assigned a tax loss period of six years.

To construct the synthetic tax rate, k_{it} is replaced by a constant (0.5) for all firms in all years.

Offshoring high-skilled jobs: EU multinationals and domestic employment of inventors

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Abstract: Firms increasingly conduct research activities in many locations. Policy makers have expressed concern that this might displace high-skilled employment in the home country, where research has traditionally been focused. We provide empirical estimates of the impact that increasing the use of inventors (high-skilled researchers) abroad has on a firm's use of inventors at home. We identify this from within firm variation across industries. We consider an instrumental variables approach to tackle possible concerns about correlated shocks within firm-industry across locations. A commonly used instrumenting approach yields imperfect instruments; we adopt the approach of Nevo and Rosen (2011), which enables us to identify bounds on the estimate. While we cannot rule out the possibility that foreign inventors displace home inventors, our main result suggests that a 10% increase in the number of inventors abroad results in a 1.9% increase in the number of inventors at home.

JEL: F21; F23; O3; H3

Keywords: multinational firms, offshoring, innovation and patents

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1 Introduction

There has been an expansion in the amount of high-tech investment and innovative activities carried out by US and European multinationals offshore.[1] Innovation activities in foreign research and development (R&D) centres are not only concerned with local product adaptation, but also with developing state-of-the-art technology (see, *inter alia*, Cantwell and Odile (1999), Zedtwitz and Gassman (2002), Branstetter (2006), Griffith and Miller (2011) and the references therein). Examples abound. For instance, in 2001 the UK-based GlaxoSmithkline opened its first R&D facility in Spain to come up with new drugs specifically designed for illnesses prevalent in developing countries.[2] Concern has been expressed by policy makers and in the media that, as firms employ more high-skilled foreign workers the employment opportunities for high-skilled workers at home will be reduced.[3]

Our contribution in this paper is to provide empirical estimates of the impact that increasing the use of inventors (high-skilled researchers) abroad has on a firm's use of inventors at home. Our identification strategy uses within firm variation across industries, allowing us to control for many confounding factors. In order to control for possible correlated within firm shocks at industry level we take a commonly used instrumenting approach. We show that this yields imperfect instruments and we adopt the empirical approach of Nevo and Rosen (2011), which enables us to identify bounds on the true estimate. While we cannot rule out the possibility that foreign inventors displace home inventors, our main result suggests that a 10% increase in the number of inventors abroad results in a 1.9% increase in the number of inventors at home.

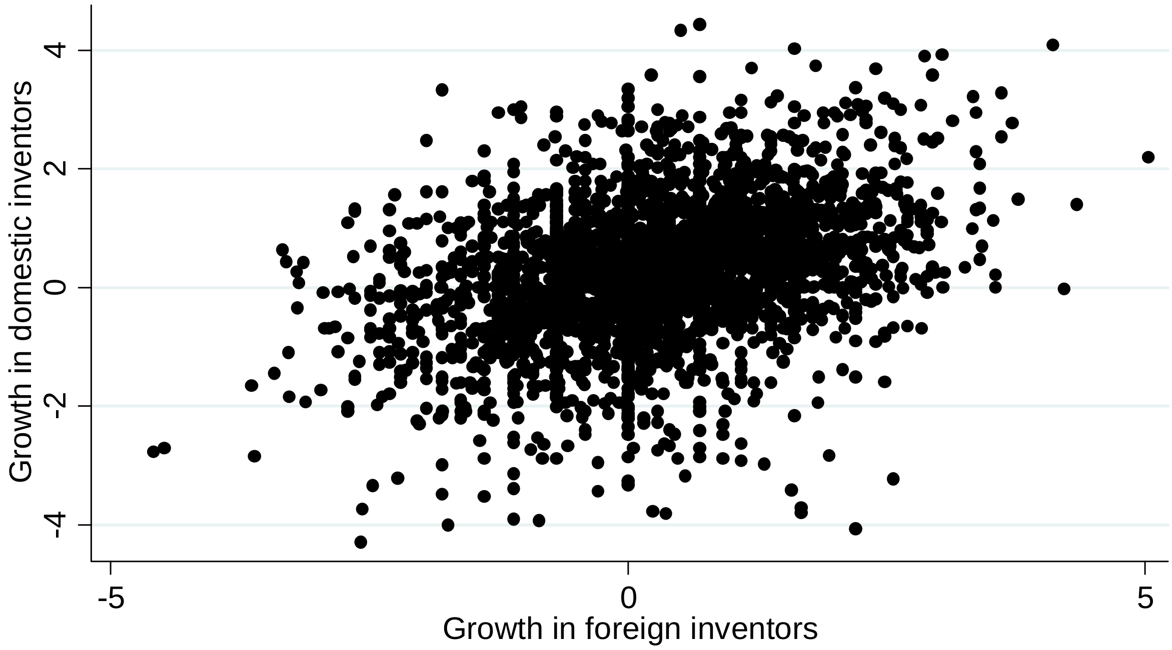
There is a substantial body of evidence that foreign competition from low-wage economies can displace low-skills workers in developed countries (see, inter alia, Braconier and Ekholm (2000), Antras et al (2006), Harrison and McMillan (2011), and Simpson (2011)). However, there is little evidence on whether overseas employment of high-skill workers displaces the domestic employment of high-skilled workers. There are important reasons to believe that the relationship between high-skilled workers in different locations may be different to that of

[1] See UNCTAD (2005) and OECD (2008). For example, business sector R&D expenditure by affiliates abroad as a percentage of domestic R&D increased in many OECD countries in the ten years to 2005 (OECD 2008, Figure 1.5). e.g. in Germany it went from around 18% to about 25%.
[2] http://www.globalhealthprogress.org/programs/ProgramDetail.php?id=774&parent=programs, last accessed 29th November 2011.
[3] See, for instance, Freeman (2006, 2009) and OECD (2007). Such concerns have also been widely publicised in the media. For two examples see: “Nightmare Scenarios”, The Economist, 5 October 2006; “How to Keep Your Job Onshore”, BusinessWeek, 20 August 2007.

low-skilled workers. Researchers in foreign locations may have expertise or knowledge that increases the research capacity or marginal product of home researchers. The recent literature has emphasised the increase in collaboration (e.g. Jones (2009)) and the importance of international research networks that combine researchers from a number of countries (Wuchty et al (2007)).[4] If foreign and domestic researchers are sufficiently complementary in the production of knowledge, then an increase in the employment of foreign researchers may increase the employment of domestic researchers.

We use data on the patenting activity of large European multinational firms to investigate this relationship. The raw correlation between the growth in the number of inventors located abroad (foreign inventors) and growth in the number of inventors based in the home country is positive, see Figure 1 (details of the data used are given in section 3). Of course, there are many potential confounding factors that may explain this raw correlation; it could arise simply because firms that have experienced positive demand shocks are increasing activity in all locations.

Figure 1. Growth of Domestic and Foreign Inventors of EU Multinational Firms



Note: The vertical and horizontal axes of the figure show normalised growth in domestic and foreign inventors respectively. Foreign inventors are defined as those located outside of a firm's home country. Each observation is the growth, defined as the log change, in inventors between two consecutive periods (1991-1995, 1996-2000, 2001-2005) for a parent firm in a specific industry. Inventors can be classified in at least one of six industries: Chemicals, Chemical Materials, Communications and Computing, Electrical and Electronics, Engineering and Pharmaceuticals. The number of observations is 3117. The number of parent firms is 736.
Source: Authors' calculation using PATSTAT matched to Amadeus and Derwent.

[4] See also Economist Intelligence Unit (2007) "Sharing the idea. The emergence of global innovation networks."

Our main empirical strategy relies on the identifying assumption that shocks to demand are common across industries within a firm-time period, and we rely on unobserved (exogenous) changes in the relative cost of employing foreign inventors to shift the optimal number of foreign inventors that a firm wants to employ. We observe firms operating in multiple industries and, within industry, operating in multiple countries. We use differential changes in the pattern of location of inventors within firms across industries.

A key concern with this approach is that it does not control for firm-industry specific shocks that are correlated across locations. To address this we take an instrumental variables approach akin to Card (2001), which exploits differential exposure to foreign cost shocks proxied by the extent of a firm's activities in the location in previous periods; this approach is used by Desai, Foley and Hines (2009) to investigate the impact of manufacturing activity at home and abroad. This IV estimate yields an implausibly high estimate. We postulate that this is because this is an imperfect instrument, in the sense that it has power but is not strictly exogenous. Drawing on recent work by Nevo and Rosen (2011), and under what we believe to be more palatable assumptions, we are able to show that the standard IV estimates are substantially upward biased, and we are able to estimate a bound on the true parameter. The bound does not rule out the possibility that the expansion in the use of foreign inventors has a modest impact on stimulating the domestic use of inventors at home within multinational firms, but nor does it rule out the possibility that it displaces them.

Our paper contributes to the growing empirical literature on the impact of multinationals' offshore activity on their home economy. This empirical literature has generally considered multinational firms from a single home country operating in manufacturing industries; although there is considerable variation in the methodologies and data used. We summarise the most relevant examples when discussing our results in the section 5. Most closely related is Desai, Foley and Hines (2009), which considers the effect of expansions of activity abroad on home activity (the intensive margin, that is conditional on location) of US multinationals operating in manufacturing industries and finds evidence that foreign investment stimulates domestic activity.[5] Another closely related paper is Harrison and McMillan (2011), which finds no effect on overall domestic labour demand of US manufacturing multinationals of changes in the wages that their affiliates pay in high-income countries. They do, however,

[5] In another context, Bresnahan et al (2002) also look at the relationship between two inputs (information communication technologies and high-skilled workers) and interpret a positive relationship as evidence of complementarities in production.

find a positive association between R&D expenditure in low- and high-income countries as a percentage of parent's sales and domestic labour demand.

The rest of the paper is organised as follows. Section 2 discusses the theoretical background and predictions. Section 3 describes the data. Section 4 describes our empirical strategy and identification issues. Section 5 presents our empirical results, and a final section summarises and discusses our findings.

2 Theoretical motivation

The impact of a multinational firm expanding its research activity offshore on research activity at home will depend on the degree of complementarity between these activities. Consider a firm that has operations in just two locations, home and abroad, and consider the effect of a decrease in the relative cost of inventors abroad on the number of inventors employed at home conditional on location; there will be two offsetting effects: a substitution and a scale effect. The substitution effect will be non-positive, as the firm substitutes towards the relatively cheaper foreign inventors. If the total amount of worldwide research activity (knowledge creation) of the firm were fixed then an increase in the use of offshore researchers would necessarily reduce the number at home. However, the decreased cost of producing knowledge will increase the firm's optimal knowledge output, and so produce a non-negative effect on the number of inventors employed at home, as the firm increases the scale of technology investment. Combining the substitution and scale effects, an overall positive impact of a change in the number of inventors abroad on the number at home requires that the scale effect outweighs the substitution effect. This in turn requires that inventors at home and abroad are sufficiently complementary in the production of knowledge – the substitution effect is smaller and the scale effect larger the greater the interaction in production.

To see this more clearly, and to understand the economic mechanisms underlying our empirical strategy, we draw on Desai et al (2009) and consider the following simple model. A multinational firm, *i,* generates an industry, *j,* specific knowledge output, $K \ (I_{ij,}^{h} I_{ij}^{a})$, by employing inventors, *I,* located in the home country, *h,* and abroad, *a*. We assume that the production of knowledge is separable across industries and from the production of final output. We allow the revenue, *R*, that a firm derives from its knowledge output in an industry to be affected by firm specific factors, F_i, such as changes in the worldwide demand for their final product, and industry specific factors, $T_{j,}$ such as a worldwide increase in the applicability of technologies used in an industry. Firms face a cost, $C\left(I_{ij,}^{h}I_{ij}^{a}\right)$, of using inventors, which differs across firms, industries and countries. The firm's problem is therefore to choose the number of inventors at home and abroad to maximise profits:

$$max_{I_{ij}^{h}I_{ij}^{a}} R_{ij}\left(K \quad (I_{ij,}^{h}I_{ij}^{a}), F_i, T_j\right) - C\left(I_{ij}^{h}, I_{ij}^{a}\right) \tag{1}$$

The first-order conditions for the choice of inventors are:

$$\frac{\partial R}{\partial K_{ij}} \frac{\partial K_{ij}}{\partial I_{ij}^{a}} = C'_{\mathrm{I^a}} \tag{2}$$

$$\frac{\partial R}{\partial K_{ij}} \frac{\partial K_{ij}}{\partial I_{ij}^{h}} = C'_{\mathrm{I^h}} \tag{3}$$

From equations (2) and (3) we see that a change in foreign costs $C'_{\mathrm{I^a}}$ directly affects the number of inventors abroad and indirectly affects the number at home by affecting the optimal knowledge output, $K_{ij.}$ To see the relationship between growth in inventors at home (dI_{ij}^{h}) and abroad (dI_{ij}^{a}), we totally differentiate (3), setting the change in the cost of employing inventors at home to 0, ($C'_{\mathrm{I^h}} = 0$), to obtain:

$$dI_{ij}^{h} = \frac{\left[\frac{\partial R}{\partial K_{ij}} \frac{\partial^2 K_{ij}}{\partial I_{ij}^{h} \partial I_{ij}^{a}} + \frac{\partial^2 R}{\partial K_{ij}^2} \frac{\partial K_{ij}}{\partial I_{ij}^{h}} \frac{\partial K_{ij}}{\partial I_{ij}^{a}}\right] dI_{ij}^{a} + \frac{\partial K_{ij}}{\partial I_{ij}^{h}} \frac{\partial^2 R}{\partial K_{ij} \partial F_i} dF_i + \frac{\partial K_{ij}}{\partial I_{ij}^{h}} \frac{\partial^2 R}{\partial K_{ij} \partial T_j} dT_j}{-\left[\frac{\partial R}{\partial K_{ij}} \frac{\partial^2 K_{ij}}{\partial I_{ij}^{h\,2}} + \frac{\partial^2 R}{\partial K_{ij}^2}\left(\frac{\partial K_{ij}}{\partial I_{ij}^{h}}\right)^2\right]} . \tag{4}$$

The first term in the numerator reflects the impact of an exogenous change in foreign inventors on domestic inventors. The second term reflects the effect of firm specific factors, and the third term the impact of industry specific factors that can drive demand for knowledge at the firm-industry level.

Equation (4) shows that the sign of the relationship between dI_{ij}^{h} and dI_{ij}^{a} is ambiguous. Under the assumption that revenue is increasing with knowledge ($\partial R / \partial K_{ij} > 0$), but at a diminishing rate ($\partial^2 R / \partial {K_{ij}}^2 \leq 0$) and that there are diminishing marginal returns in the production of knowledge ($\partial^2 K_{ij} / \partial {I_{ij}^{h}}^2 < 0$) the denominator of (4) is positive. The sign of the affect of dI_{ij}^{a} on dI_{ij}^{h}, is therefore determined by the first bracket in the numerator. Given the assumptions above, the first term in that bracket will be positive only if $\partial^2 K_{ij} / dI_{ij}^h dI_{ij}^a > 0$. That is, if inventors at home and abroad are complementary in the production of knowledge. The second term in the bracket will be non-positive, because $\partial^2 R / \partial K_{ij}{}^2 \leq 0$. Combined, the first bracket will have a positive sign if and only if the first term outweighs the second, which in turn requires that inventors at home and abroad are *sufficiently* complementary in the production of knowledge. Whether this is the case is an empirical question. Furthermore, equation (4) suggests that industry (T_j) and firm (F_i) level variables, such as a positive firm level demand or industry level shock, could lead to an expansion of both inputs even if they are unrelated in production (i.e. if the first bracket in the numerator is zero).

We investigate the relationship between growth in inventors at home and abroad by estimating the empirical relationship suggested by (4). We discuss the empirical implementation of this specification further below, after introducing the data.

3 Data

3.1 Firm-level data

We use information on the inventors employed by large European multinational firms. We observe firms that have innovative activities in multiple industries and, within industries, both in their home country and in at least one foreign country (abroad). Our analysis is conditional on location choice. We use within firm variation in the change in inventors at home and abroad across different industries. Our identifying assumption is that the differential rates of within-firm changes (above the trends that are common across industries) represent changes that are not driven by firm-level shocks (that simultaneously determine employment of inventors at home and abroad).

Inventors are measured as those listed on European Patent Office (EPO) patent applications filed over the period 1991-2005.[6] These data provide information on all of the inventors that created the technology underlying a patent application, including where they were located (their residential address). We start with all patent applications made by corporate entities in European countries or the US. We match these firms, which may be subsidiaries of larger

[6] Data are recorded in the EPO's Worldwide Patent Statistical Database (PATSTAT). We use patent applications (not only granted patents) and the application priority date, which is the date closest to the point of invention.

firms, to their ultimate parent firm using information from accounts data and a range of out sources.[7] The result is information on the inventors, located anywhere in the world, listed on the patent applications filed directly or indirectly (via an associated US or European subsidiary) by European firms located in any of ten European countries.[8] Column (1) of Table 1 shows the total number of parent firms (many of which are associated with multiple subsidiaries) that file at least one patent application in the period 1991-2005 and have been matched to accounts data. Column (2) shows how the 32,590 firms are distributed across countries. We define inventors as being located abroad (at home) if they are in a different (the same) country as the headquarters of the parent firm.

Patent applications are an attractive measure of research activity because they provide a consistent measure of the location of inventors at the firm level across all countries. Patents have been used for this purpose in a number of applications.[9]

We classify patent applications (and therefore inventors) into industry groups using the Derwent Innovation Index, which is compiled by Thompson for commercial purposes and classifies patent applications according to the industries in which the invention has an application.[10] We use six broad industry groups: Chemicals, Chemical Materials, Communications and Computing, Electrical and Electronics, Engineering and Pharmaceuticals. An individual patent application can be classified into multiple industries, recognising that some technologies will have more than one possible application. In such cases, we allow the associated inventors to enter the measures of firm-industry growth for each relevant industry group.

Our interest in this paper is to consider the impact of firms expanding offshore activities on activities at home. We consider this at the intensive margin. That is, we look at changes in inventors for firms that are already operating at home and abroad, thereby abstracting from

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[7] We have matched the corporate applicants (i.e. excluding individuals, universities and research institutions) of EPO patent applications from a number of European countries and the US to firms listed in Bureau van Dijk's Amadeus and Icarus databases. In analysis, we use those firms that we have successfully matched to accounts data; matching rates vary by country. See Abramovsky *et al* (2008) for discussion of the matching process and resulting data.

[8] Firms are headquartered in one of the following ten countries: Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden and UK.

[9] See, for instance, Griliches et al. (1984) and Griliches (1990). Breschi and Lissoni (2009) and Nicholas (2009) provide recent application of this type of data to look at the mobility of high-skilled workers and co-invention networks and the role of spatial diversity in invention.

[10] See Abramovsky et al (2008), section 5, for more details on this industry classification. Note that this is distinct from firm level industry classifications (such as NACE codes) which provide a broad measure of the primary industry in which a firm operates and from classifications attached to patent applications by patent offices (IPC codes) which document the embodied technology.

the initial decision over whether to put any inventors offshore. Across the period 1991-2005, we see that 81% of firms conduct no innovative activity offshore – for these firms all inventors are based in the firm's home country. On average these tend to be smaller firms in terms of the total number of patent applications filed across 1991-2005; at the median, firms with no inventors offshore file 5 patent applications while those with at least one inventor offshore file 1,397.

Column (3) of Table 1 shows the number of firms that are associated with a change in inventors both at home and in at least one foreign location between 2 consecutive 5-year periods (1991-1995, 1996-2000, 2001-2005). There are 1,241 such firms, distributed across countries as shown in column (4). For these firms we observe variation in the growth in inventors at home and abroad across firms and, in some cases, across two periods within a firm.

The variation in our data that allows us to identify the relationship between inventors at home and abroad comes from large multinationals that operate in multiple industries. It is widely know that innovative activities generally, and patenting specifically, is highly concentrated in large multinational firms.[11] We focus our attention on those firms that change their employment of inventors both at home and abroad in at least two different industries, in at least one period. Our main estimation sample therefore comprises 736 large European multinational firms, see column (5) of Table 1. Although these firms represent only a small proportion of total firms (2.3%) they account for the majority of patenting activities: 60.7% of inventors located in firms' home countries and 79.7% of the inventors located offshore. We observe variation in the growth in inventors at home and abroad across firms and, across industries within firms. In some cases we also observe firms in two periods.

This selection of firms is a restriction. We assume that whether a firm innovates at home and abroad in two or more industries in each of two consecutive periods is not systematically related to the relationship between foreign and home inventors. In the results section, we report that results for the larger sample of firms as a robustness check (column (3) in Table 1), showing that we find comparable results.

[11] UNCTAD (2005) figures show that more two-thirds of world business R&D is carried out by multinational firms. See also Bloom and Van Reenen (2002) and Criscuolo, Haskel, and Slaughter (2010).

Table 1: Number of firms, by country of parent firm, 1991-2005

	All firms		Firms with growth in inventors at home and abroad		Main estimation sample: Firms that innovate at home and abroad in two or more industries in each of two consecutive periods				
Parent country	Number of firms (1)	Distribution across countries (2)	Number of firms (3)	Distribution across countries (4)	Number of firms (5)	Distribution across countries (6)	% of all parent firms = (5)/(1) (7)	% of all home activity (8)	% of all foreign activity (9)
Belgium	787	*2.4*	57	*4.6*	39	*5.3*	5.0	70.5	74.9
Denmark	1,024	*3.1*	59	*4.8*	36	*4.89*	3.5	59.7	47.6
Finland	939	*2.9*	39	*3.1*	24	*3.26*	2.6	61.9	75.0
France	3,330	*10.2*	128	*10.3*	79	*10.73*	2.4	66.4	85.4
Germany	10,710	*32.9*	475	*38.3*	262	*35.6*	2.4	63.6	78.8
Italy	5,062	*15.5*	84	*6.8*	50	*6.79*	1.0	22.8	43.6
Netherlands	2,026	*6.2*	71	*5.7*	44	*5.98*	2.2	79.0	65.2
Norway	686	*2.1*	21	*1.7*	10	*1.36*	1.5	32.4	47.3
Sweden	1,932	*5.9*	92	*7.4*	55	*7.47*	2.8	55.7	70.6
UK	6,094	*18.7*	215	*17.3*	137	*18.61*	2.2	46.7	75.4
Total	32,590	*100*	1,241	*100*	736	*100*	2.3	60.7	79.7

Notes: Column (1) shows the total number of parent firms that have filed at least one patent application across 1991-2005 and have been matched to firm accounts data. Column (3) shows those firms that are associated a change in inventors in both the parent firm's home country and at least one other country between 2 consecutive periods. These firms underlie Figure 1. Column (5) shows those firms that change their employment of inventors both at home and abroad in at least two different industries. This is our main estimation sample. Columns (2), (4) and (6) show the distribution of firms across parent countries. Column (7) shows the proportion of all firms that are included in the main sample. Column (8) shows the inventors located in firms' home countries (home inventors) and included in our sample (i.e. listed on the patent applications of firms in column (5)) as a proportion of the total home inventors associated the full sample (column (1)). Column (9) produces the equivalent proportion for inventors located outside of firms' home countries (foreign inventors).
Sources: Authors' calculation using matched data from Amadeus, Icarus, PATSTAT and Derwent Innovation Index.

Table 2 shows the distribution of the foreign inventors in our sample across countries, by country of the parent firm.[12] Each inventor is counted once per patent (independently of the number of industries in which inventors has been classified).[13] The first row, for example, shows the proportion of the inventors located outside of Belgium but listed on the patent applications of Belgium firms that are located in each of the countries or country groups displayed in the columns. We see that the majority of foreign inventors in our sample were located in Western Europe (47%) or the US (46%). Very few were located in emerging economies. While emerging economies have become a more important locations for western multinationals innovative activities over time they still represent a small proportion of total activity (Griffith and Miller (2011), OECD (2008)).

Table 2: Distribution of location of foreign inventors, by country of parent firm, 1991-2005

	Location of foreign inventors									
Parent country	France	Germany	UK	Other Western Europe	US	Other Developed	Eastern Europe	Emerging Economies	All others	Total
Belgium	6.8	33.4	15.3	22.4	19.7	1.1	0.4	0.7	0.4	100
Denmark	1.5	11.4	5.0	27.5	46.7	4.3	2.7	0.8	0.2	100
Finland	1.0	16.7	17.1	21.0	32.0	5.1	2.4	3.8	0.9	100
France	-	35.3	4.6	19.2	34.3	3.1	1.4	2.0	0.3	100
Germany	9.5	-	8.3	30.9	39.9	6.1	1.7	1.9	1.7	100
Italy	22.6	20.6	10.0	17.6	21.4	3.6	2.0	1.3	0.9	100
Netherlands	12.3	26.1	14.9	10.5	29.9	3.3	0.5	2.1	0.4	100
Norway	15.3	39.6	7.2	27.1	8.8	0.9	0.4	0.6	0.2	100
Sweden	5.1	26.4	7.3	26.4	26.9	5.3	1.4	0.8	0.5	100
UK	2.1	4.1	-	12.1	75.5	3.4	0.8	1.3	0.6	100
Total	5.3	16.0	6.5	19.2	45.5	4.0	1.2	1.7	0.7	100

Notes: Each row shows the percentage of foreign inventors listed on patent applications filed by firms in the parent country indicated by the row and located in each country/country group. Included inventors are those in the main estimation sample. 'Other Western Europe' includes Austria, Belgium, Denmark, Finland, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain and Sweden. 'Other Developed' includes Australia, Canada, Israel and Japan. 'Eastern Europe' includes Belarus, Bulgaria, Czech Republic, Hungary, Latvia, Lithuania, Poland, Republic of Moldova, Romania, Russia, Slovakia, Ukraine Estonia. 'Emerging Economies' includes South Africa, Brazil, China, India, Singapore, Taiwan and Korea.
Sources: Authors' calculation using matched data from Amadeus, Icarus and PATSTAT.

[12] Across the period 1991-2005, for all firms in our main sample, 67% of inventors were located in firms' home countries. This figure represents a fall from 70% in 1991-1995 to 65% in 2001-2005. There are substantial differences across the country of the parent firm in the extent to which activity is conducted at home.
[13] In the main sample, inventors are counted as many times as there are industries associated with the patent application on which they are listed. The patterns in Table 2 are not changed by counting inventors in that way.

3.2 Country level data

We also use country level data to proxy for the foreign costs of employing inventors. As discussed below, we use this as an instrument for changes in inventors abroad.

We use GDP per capita measured in US $ at constant prices and using constant PPPs and a 2005 base year. Data are from http://stats.oecd.org (measure: GDP, US $, constant prices, constant PPPs, OECD base year). We calculate growth as the log change across two periods in the mean of GDP per capita across the 5 years within a period. For the countries for which we do not have GDP data (which make up only a small fraction of inventors locations) we use the value for the EU27.

4 Empirical approach and identification strategy

4.1 Main empirical specification

Our interest is in estimating how the growth in the number of inventors a firm employs at home changes in response to an exogenous increase in the number of foreign inventors employed. Equation (4) suggested that there are two potentially confounding factors that may drive a positive association other than complementary in production: firm specific and industry specific factors that will potentially affect the employment of inventors in all countries. As a result simple OLS regression of the change in inventors at home on the change in inventors abroad will be biased. We estimate the following empirical counterpart of equation (4), which relates changes in inventors at home (ΔI_{ijt}^{h}) to changes in foreign inventors (ΔI_{ijt}^{a}), controlling for these confounding factors.

$$\Delta I_{ijt}^{h} = \beta \Delta I_{ijt}^{a} + \gamma_{it} + \delta_j + \varphi_t + u_{ijt} \qquad (6)$$

Firm-period effects are captured by γ_{it}, industry effects by δ_j, and common macro shocks by φ_t. We introduce a time, *t,* subscript here to indicate that some firms are observed in more than one period. Identification comes from variation in growth in inventors within individual firms (across industries and time), within industries (across firms) and over time. Using this approach we are able to control for many potentially confounding factors that may generate an association due to factors other than complementary in production, for example, shocks to firm demand or industry level demand or cost shocks.

Within a firm, at the industry level, the optimal number of foreign inventors relative to home inventors will be affected by exogenous changes in the cost of using foreign inventors (e.g. the wages Glaxo Smithkline pays to inventors working in pharmaceuticals in Spain) or in the return of using these inventors (say, for example, because a new public lab is established near a firm's R&D facility). We expect differential trends in the exogenous changes that drive the relative attractiveness of inventors across locations within industries. We compare trends in the use of inventors at home and abroad across industries within firms in order to isolate the effect of such exogenous variation. Put another way, we are able to control (using firm-time effects) for any firm-level shocks (that simultaneously determine the employment of inventors at home and abroad) that are common across different industries within a firm, and industry level effects to control for industry level shocks.

We define changes in inventors ($\Delta \mathrm{I}_{\mathrm{ijt}}$) as the log difference in the number of inventors, because the distribution of percentages changes is skewed (so better approximated by a log normal than a normal distribution), and because these have been shown to have nicer properties than the ordinary percentage to measure relative changes (Tornqvist et al (1985)).

The coefficient of interest, β, reflects the change in growth of domestic inventors for a one percentage point increase in the growth of foreign inventors.[14] A positive β would suggest that foreign activity does not displace home activity and be consistent with inventors at home and abroad being sufficiently complementary in the production of knowledge that, in response to an exogenous change in the costs of employing foreign inventors, the number of domestic inventors increases.

We assume that the idiosyncratic error term, u_{ijt}, which will capture firm-industry-year specific shocks, is heteroskedastic, thereby allowing for arbitrary correlation of shocks within a firm, and across technologies and periods; we adjust standard errors accordingly by clustering them at the firm level.

[14] Growth in the number of inventors ($\Delta I_{ijt}^{\mathrm{x}}$ for *x=h,a*) is defined as the log changes in the number of inventors (i_{ijt}): $\Delta I_{ijt}^{x} = ln\left(i_{ijt}^{x}\right) - ln(i_{ijt-1}^{x})$. Therefore $\beta = \frac{\delta \Delta I_{ijt}^{h}}{\delta \Delta I_{ijt}^{a}} = \frac{\delta ln\left((i_{ijt}^{h}/i_{ijt-1}^{h})\right)}{\delta ln\left((i_{ijt}^{a}/i_{ijt-1}^{a})\right)}$ is the percentage change in the ratio of home inventors across two periods $(i_{ijt}^{h}/i_{ijt-1}^{h})$ for a one percent change in the ratio of foreign inventors across two periods $(i_{ijt}^{a}/i_{ijt-1}^{a})$.

4.2 Identification

A potential concern with our main empirical specification is that it does not account for firm-industry specific shocks that may lead to growth in inventors both at home and abroad. To address this we use an instrumental variable (IV) strategy, akin to the approach taken in Card (2001) and also used in Desai, Foley and Hines (2009), which exploits differential expose to changes in costs associated with employing foreign inventors.[15]

As in Desai, Foley and Hines (2009), we posit that changes in foreign countries' economic activity reflect changes in the productivity of workers in these locations, and hence changes in the real cost of employing them, that can be treated as exogenous to a multinational firm.

Firms will have different exposure to these shocks. We proxy this exposure using the geographic distribution of a firm's inventors in the previous period. This yields a firm-technology specific instruments for the growth in foreign inventors that combines country-specific measures of GDP per capita with firm-industry-specific country weights. The resulting instruments, Z_{ijt}, are :

$$Z_{ijt} = \sum_{c \epsilon ijt} \frac{I^{a}_{ijct-1}}{\sum_{c} I^{a}_{ijt-1}} \Delta GDP_{ct} \quad (5)$$

These weighted averages of foreign GDP growth will be used as instruments to capture exogenous changes of foreign employment of inventors. The location of foreign activity differs significantly across firms and within firms across industries. We assume that the distribution of activity in the previous period captures the firm exposure to cost shocks in that country, and that it is exogenous to any subsequent changes in domestic research activity.

We expect those firms that had inventors in countries that later experienced high growth are more likely to experience a decrease in their cost of doing research in that location and therefore to increase their investment in knowledge. Since the distribution of inventors across countries differs across firms and, within firms, across technologies, we expect different rates of growth of foreign activities, and correspondingly different outcomes from home inventors.

A concern we have is that this instrument is imperfect, in the sense that it has power to explain independent variation in inventors employed abroad, but that lagged inventor shares

[15] To empirically identify the effect of changes in the use of foreign inventors we would like ideally to measure exogenous changes in the cost of or return to using foreign inventors at the firm-location-technology level that would directly affect the number of foreign inventors, but not the number of home inventors. We have not been able to obtain such data.

may not be independent of the error term. For example, this could be true if foreign economic growth directly stimulates demand for firms' knowledge output and, as a consequence, inventor demand in all locations or if firms that were planning rapid expansion abroad were more likely to *choose* to locate in foreign countries that were growing - i.e. the initial distribution of inventors across foreign countries is endogenous to current domestic activities. To the extent that these factors are firm or industry specific and not firm-industry specific, they will be controlled for with firm and industry fixed effects.

We allow for the possibility of our instrument being imperfect. Nevo and Rosen (2011) set out a method for indentifying analytical bounds on parameters in the presence of imperfect instruments.

Let z_{ijt} denote our instrument. The standard IV assumptions require that the correlation between the instrument and the endogenous variable, $corr(\Delta I^a_{ijt}, z_{ijt})$, is significant and that the instrument is strictly exogenous, $corr(z_{ijt}, u_{ijt}) = 0$. It is the second (untestable) condition that raises concerns. Nevo and Rosen show (Lemma 2) that when an instrument and the endogenous variable are positively correlated, 2SLS using an imperfect instrument (i.e. where $corr(z_{ijt}, u_{ijt}) \neq 0$) will not even necessarily reveal the direction of the bias in an OLS estimator. However, it is possible to relax the strict exogeneity assumption and under alternative, and we believe more palatable in this setting, assumptions we are able to use information contained in the instrument to identify bounds on the true estimate. There are two key assumptions:[16]

1) $corr(\Delta I^a_{ijt}, u_{ijt}) * corr(z_{ijt}, u_{ijt}) \geq 0$

i.e. the correlation between the instrument and the error has the same sign as the correlation between the endogenous regressor and the error (assumption A3 in Nevo and Rosen). We assume both correlations are positive. We think that it is plausible that any firm-industry shocks in u_{ijt} will be positively correlated with growth in inventors abroad. For example, a firm-industry demand shock could trigger an increase in demand for inventors in that industry in all locations. Likewise we think it plausible that if GDP growth in foreign locations is correlated with the error term, the correlation will be positive, as discussed before.

2) $|corr(\Delta I^a_{ijt}, u_{ijt})| \geq |corr(z_{ijt}, u_{ijt})|$

[16] As with a standard IV estimator, we have to also assume that all variables are identically and independently distributed and that all variables except the changes in foreign inventors are exogenous (Assumptions A1 and A2 in Nevo and Rosen).

i.e. the instrument is less endogenous than the regressor (assumption A4 in Nevo and Rosen). We think this is a reasonable assumption – the correlation between the instrument and the error terms should be not as high as the correlation between the endogenous variable and the error term, given that there might be other firm-industry specific omitted factors affecting ΔI_{ijt}^{a}.

Under these assumptions Nevo and Rosen show that the true β lies in the region B^{*}, where $B^{*} = (-\infty, \min\{\beta^{IV}, \beta_{V(1)}^{IV}\}]$ and β_{V1}^{IV} is the probability limit of the traditional 2SLS estimator for β when $V(1) = \sigma_z \Delta I^a - \sigma_{\Delta I^a} z$ is used as an instrument for ΔI^a. That is, β lies in an open bound that has a 2SLS estimate as the upper bound.

5 Results

Table 2 provide summary statistics for the dependent and explanatory variables and instrument we use. We see that at both the mean and median, growth in inventors abroad is similar to growth in inventors at home. There is substantial variation in the growth of inventors at home and abroad at the parent firm-industry level (the standard deviation is more than double the mean). Not surprisingly, the average growth in the firm-weighted measures of foreign GDP per capita, used in our IV specifications, is considerably lower than the variable it is used to instrument for, growth in foreign inventors.

Table 2. Descriptive statistics

	Min	Mean	Median	Max	Standard Deviation
Change in Domestic Inventors ΔI_{ijt}^{h}	-4.29	0.27	0.29	4.43	1.12
Change in Foreign Inventors ΔI_{ijt}^{a}	-4.58	0.28	0.29	5.03	1.16
Firm weighted change in foreign GDP per capita	-0.01	0.07	0.07	0.36	0.05

Notes: Notes: Number of observations (firm-industry-period) is 3117.
Sources: Authors' calculation using matched data from Amadeus, Icarus and PATSTAT, and OECD's Main Science and Technology Indicators.

Table 3 shows the results from estimating equation 5. Column 1 includes industry and time effects. Column 2 adds firm effects and column 3 adds firm-time effects. In all cases we find a positive estimate of β. The point estimate of β is reduced – and is statistically lower at the 5% level - with the addition of firm effects. There are no statistical differences between the results with firm and firm-time effects. Overall, this is in line with our expectations – the firm and firm-time effects are operating to net out unobservable factors such as demand shocks or productivity shocks that drive a positive correlation between changes in inventors at home and abroad. This suggests that foreign activity does not displace home activity, and can be interpreted as evidence that inventors at home and abroad are sufficiently complementary in the production of knowledge. Using the results of column (3) as our main point of reference, this means that an increase in 10% in inventors abroad there will be a 1.9% in inventors at home.

We believe that the estimate in column (3) already nets out many of the most important confounding factors and therefore reflects the exogenous effect of changes in the use of foreign inventors on domestic inventors. However, the coefficient reported in column (3) would still be positively biased in the presence of significant firm-industry specific shocks that simultaneously affect growth in inventors at home and abroad.

In columns (4)-(6) we instrument changes in inventors abroad using firm-industry-time specific measures of foreign GDP growth. We repeat the pattern of effects across the three columns. The associated first stages are shown in columns (1)-(3) of Table 4. We see that the instrument has significant explanatory power; the growth in the GDP per capita of countries in which firms previously employed inventors is positively associated with growth in the number of inventors employed in foreign locations.

The IV results in Table 3 suggest a substantial *increase* in the estimate of β. Although we note that the IV estimate is much less precise, so it is not statistically different from the OLS estimate, the point estimate with firm-period fixed effects is much higher relative to the estimates in columns (1)-(3), e.g. it is around 75% higher when comparing column (6) to (3). We find this result puzzling: we expect a positive correlation between the endogenous variable and the error term and therefore upward bias in the OLS coefficient. This pattern was also observed in Desai et al (2009).

Our explanation of this result is that the instrument is imperfect, in which case 2SLS does not necessarily reveal even the sign of the bias in the OLS estimate.[17]

[17] Another reason why the IV point estimate might be higher than the OLS estimate is if the relationship between inventors at home and abroad is heterogeneous across firms and technologies. The standard IV estimate will capture the impact for those firm for which we observe variation in the instrument (the so-called "local average treatment effect"). This could lead to IV estimates that are higher than OLS ones.

Following Nevo and Rosen (2011) we calculate bounds, based on the assumptions 1 and 2 discussed above. For each category of fixed effects, we calculate the 2SLS estimator using $V(1) = \sigma_z \Delta I^a - \sigma_{\Delta I^a} z$ as an instrument for ΔI^a. Recall that the true β lies in the region B^*, where $B^* = (-\infty, \min\{\beta^{IV}, \beta^{IV}_{V(1)}\}]$. We find that in each case $\beta^{IV}_{V1} < \beta^{IV}$, therefore β^{IV}_{V1} determines the upper bound. The associated bounds are reported in columns (7) and (9) of Table 3. Considering column (9) we can conclude that $\beta \leq 0.164$. The confidence interval of the bound includes the estimate in column (3) (our main estimate) but not the IV estimate in column (6).

This is an important result. It shows that (under the relevant assumptions) the OLS estimator, accounting for firm level effects, performs better than the 2SLS estimator.

If one believes that there are significant firm-industry specific shocks (in addition to firm-time shocks), our results suggest that we cannot reject a positive relationship, but given that we are only able to identify an open bound, it does not rule out a zero or negative relationship.

The results in tables 3 and 4 are based in a sample of multinational patenting firms that operate in multiple industries. One may be concerned that selecting this sample of firms is problematic. As a robustness check, Table 5 presents results using a larger sample of firms that display growth at home and abroad in at least one industry (those in column (3) of Table 1). We calculate growth in inventors at the firm level (rather than at the firm-industry level) and exploit variation in growth across firms and across time. The drawback of using this sample is that we cannot control for firm fixed effects.

Column (1) of Table 5 presents the OLS result, which is similar to the OLS result without firm effects using our more restrictive sample. The same is true when IV and Nevo and Rosen methods are applied in columns (2) and (3) respectively. The results are similar to columns (4) and (7) of Table 3.

Table 3: Effects of growth in foreign inventors on growth in domestic inventors; main sample

Dependent variable: growth in home inventors, ΔI_{ijt}^{h}	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV	(7) IV bounds	(8) IV bounds	(9) IV bounds
Growth in foreign inventors, ΔI_{ijt}^{a}	0.33	0.211	0.19	0.651	0.34	0.329	(-∞, 0.269]	(-∞, 0.184]	(-∞, 0.164]
	[0.025]**	[0.033]**	[0.027]**	[0.155]**	[0.11]**	[0.149]*			
	(0.281 - 0.379)**	(0.146 - 0.276)**	(0.136 - 0.244)**	(0.347 - 0.955)**	(0.124 - 0.556)**	(0.038 - 0.621)*	(-∞, 0. 342)	(-∞, 0. 257)	(-∞, 0.230)
Industry and time effects, δ_j, φ_t	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm effects, γ_i	no	yes	yes	no	yes	yes	no	yes	yes
Firm-time effects, γ_{it}	no	no	yes	no	no	yes	no	no	yes
R-squared	0.191	0.655	0.82	0.092	0.183	0.042			
Joint significance of instruments									
F statistic				39.33	33.44	16.03	0.19		
P value				0.00	0.00	0.00			

Notes: The number of observations (firm-industry-period) is 3117. There are 736 firms (i) and 1,035 firm-time (it) effects. Robust standard errors clustered at the firm level are displayed in squared brackets. 95% confidence intervals are displayed in brackets. Columns (7)-(9) report confidence intervals for the bound results. The upper bound of the confidence interval is the upper bound of the confidence interval on the β_{V1}^{IV} *estimate. In columns (4)-(6) the instrument is a firm-industry- period weighted measure of foreign GDP per capita. * significant at 5%; ** significant at 1%.*

.

Table 4: Growth in foreign inventors and changes in foreign costs: first stages

Dependent variable: growth in foreign inventors	(1) IV: GDP	(2) IV: GDP, FE Firm	(3) IV: GDP, FE Firm-Period
Firm-weighted growth in foreign GDP	3.913	6.468	4.138
	(0.624)**	(1.118)**	(1.033)**
Industry and time effects	yes	yes	yes
Firm effects	no	yes	yes
Firm-time effects	no	no	yes
Observations	3117	3117	3117
R-squared	0.11	0.56	0.77
Joint significance of instruments			
F statistic	39.33	33.44	16.03
P value	0.00	0.00	0.00

Notes: See notes to Table 3. Columns (1)-(3) correspond to the first stages of the 2SLS estimates reported in columns (4)-(6) respectively in Table 3.

Table 5: Effects of growth in foreign inventors on growth in domestic inventors

Dependent variable: growth in home inventors, ΔI_{it}^{h}	(1) OLS	(2) IV	(3) IV bounds
Growth in foreign inventors, ΔI_{it}^{a}	0.337	0.458	(-∞, 0.32]
	[0.024]**	[0.195]*	(-∞, 0.393)
	(0.289 - 0.385)**	(0.076 - 0.840)*	
Industry and time effects, δ_j, φ_t	yes	Yes	yes
R-squared	0.22	0.21	
Joint significance of instruments			
F statistic			
P value			

Notes: Growth in inventors is calculated at the firm-period level. Number of observations (firm-period) is 1,732. There are 1,241 firms (*i*). Robust standard errors clustered at the firm level are displayed in squared brackets. 95% confidence intervals are displayed in brackets. * significant at 5%; ** significant at 1%. Columns 3 reports confidence intervals for the bound results.
Sources:

How do these results compare to other results in the literature that look at the within-firm effects of using foreign inputs on the demand for domestic inputs? There is no clear evidence on whether overseas employment of high-skill workers displaces the domestic employment of this type of workers within multinational firms. To date much of the empirical literature has considered the impact of multinationals' decisions to use foreign capital or employees in the production of manufactured goods. There are important differences in the methods used, data and time periods covered. A key difference is whether studies use data on foreign wages and produce estimates of cross-price elasticities or estimates of the constant output elasticity of substitution, or use data on growth in activities at home and abroad and look at the impact of using foreign inputs on the demand for domestic inputs. Another key difference is whether the type of foreign investment is being considered, i.e. whether foreign investment is of a horizontal or vertical nature.

Harrison and McMillan (2011) estimate the marginal effect of changes in foreign wages on home employment using micro data on US multinationals for the period 1982-1999, conditional on investment abroad and using a standard labour demand equation. They find that home employment in the US is increased when foreign wages decrease in low-wage countries for firms that engage in vertical foreign investment (VFDI), which is consistent with the idea of complementarities between inputs abroad and home. However, they find no effect of foreign wages in high-wage countries on US employment of these multinationals, but they do not distinguish employment at home by skill level. Muendler and Becker (2010) estimate constant output elasticities of substitutions in simultaneous system of share equations derived from a translog cost function. They consider labour at home and in different foreign regions for German multinationals and find that, conditional on investment abroad, distant regions (potentially those with low wages and lower skills relative to Germany) do not substitute for labour at home, which is consistent with the findings of Harrison and McMillan (2011). Borga (2005) looks at the correlation between employment of US multinationals at home and abroad, but does not control for common shocks or characteristics that may drive both trends simultaneously. Desai et al (2009) look at the impact of expansions of activity abroad on home activity of US multinationals. They use an instrument variable approach to isolate exogenous variation in expansion in foreign activities, using firm specific weighted growth rates in foreign gross domestic product per capita as an instrument. Similar to our findings, they find that firms that expand abroad also simultaneously expand their domestic activities.

6 Summary and discussion

Our contribution in this paper has been to provide empirical estimates of the relationship between European multinational’s employment of inventors (high skilled researchers) at home and abroad. It is motivated by concerns that, as firms employ more high skilled workers abroad, there will be detrimental effects on the employment of inventors at home.

Identification of the effect of growth in foreign inventors on growth in home inventors comes from the fact that we observe the same firm operating in multiple industries and multiple time periods. This allows us to for common correlated firm-level shocks. However, this strategy relies on the assumption that there are not shocks at the firm-industry level that are correlated within a firm across locations. To address this concern we use a standard instrumental variables approach that relies on variation in the intensity of exposure to shocks to foreign costs. Our results raise concerns that this instrument is imperfect – that is, it is a significant predictor of growth in foreign inventors but is not strictly exogenous. We allow for this possibility by estimating a bound for our coefficient of interest under a set of assumptions that we find more plausible.

Our main result suggests that a 10% increase in the number of inventors abroad results in a 1.9% increase in the number of inventors at home. The bounds we estimate do not rule out this estimate, but we also cannot reject the proposition that increasing the use of foreign inventors will displace domestic inventors.

A positive relationship is consistent with complementarities in production and suggests that growth in foreign inventors stimulates the growth of inventors at home. Because we estimate the reduced form relationship between inventors at home and abroad we do not identify the direct mechanism by which they are related. We cannot rule out that a positive relationship between employment abroad and at home is due to other factors than complementarities.

We also note two other important caveats that we have not addressed. First, we do not consider the decision of firms to start offshoring high skilled researchers – our analysis identifies the relationship between growth in inventors at home and aboard for large firms which already operate in multiple countries (see Harrison an McMillan (2011). Second, we do not consider the effect of multinational firms' expansions abroad on other domestic activities within firms, including other innovative activities such as development, or on other firms (see Braconier and Ekholm (2000)).

Our results speak to a number of policy related concerns. We speak directly to concerns that Western European multinationals will substitute away from high skilled researchers in home countries towards those located abroad. Similar concerns have been raised (and studied) in relation to other groups of workers. The key difference in this context is that high skilled researchers are associated with the innovations and technological advances that underpin growth in developed economies. They are also intrinsically linked to the important spillovers that arise in the creation of new ideas – inventors embody tacit knowledge that others, often those in close geographical proximity, benefit from. For these reason, governments are keen to encourage firms to undertake innovative activities in their countries.

There are also long running concerns over the relatively low investment in R&D in Western European countries compared to the US and, more recently China.[18] There are a number of possible reasons for this.[19] Our results suggest that, over the previous two decades, this trend has not necessarily been the direct result of European multinational's moving innovative activities offshore.

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[18] In 2000 the Lisbon Agenda set an explicit target to increase R&D undertaken in the EU to 3 per cent of GDP by 2010. This target has been missed: the latest figures (2007) show that business expenditure on R&D in the EU-15 amounts to 1.2% of GDP, compared with 1.9% in the US and 1.1% in China. As emphasized before, this is a major concern in Western European countries, since investment in technology is a key factor in cross-country differences in economic growth and income (see Acemoglu 2008).

[19] For example, supply side factors such as a shortage in the supply of workers with the right type of skills or demand side factors that may result in lower demand-driven innovations (see, for example, Soete (2010)).

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Corporate taxes and the location of innovative activity

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Motivation I – IP is important and mobile

- Intangible capital accounts for growing share of inputs
  - OECD described growing significance intellectual property & its simultaneous use by many different parts of a firm as *"one of the most important commercial developments in recent decades."*
  - since the mid 1990s UK investment in intangible (knowledge) assets has been greater than that in fixed capital and is now about 50% higher
- The income from IP is highly mobile
  - A tax lawyer quoted in the New York Times noted:

    "…most of the assets that are going to be reallocated as part of a global repositioning are intellectual property…that is where most of the profit is."
  - A front page story in the Wall Street Journal described how Microsoft saved at least $500m in taxes by licensing its intellectual from an Irish subsidiary

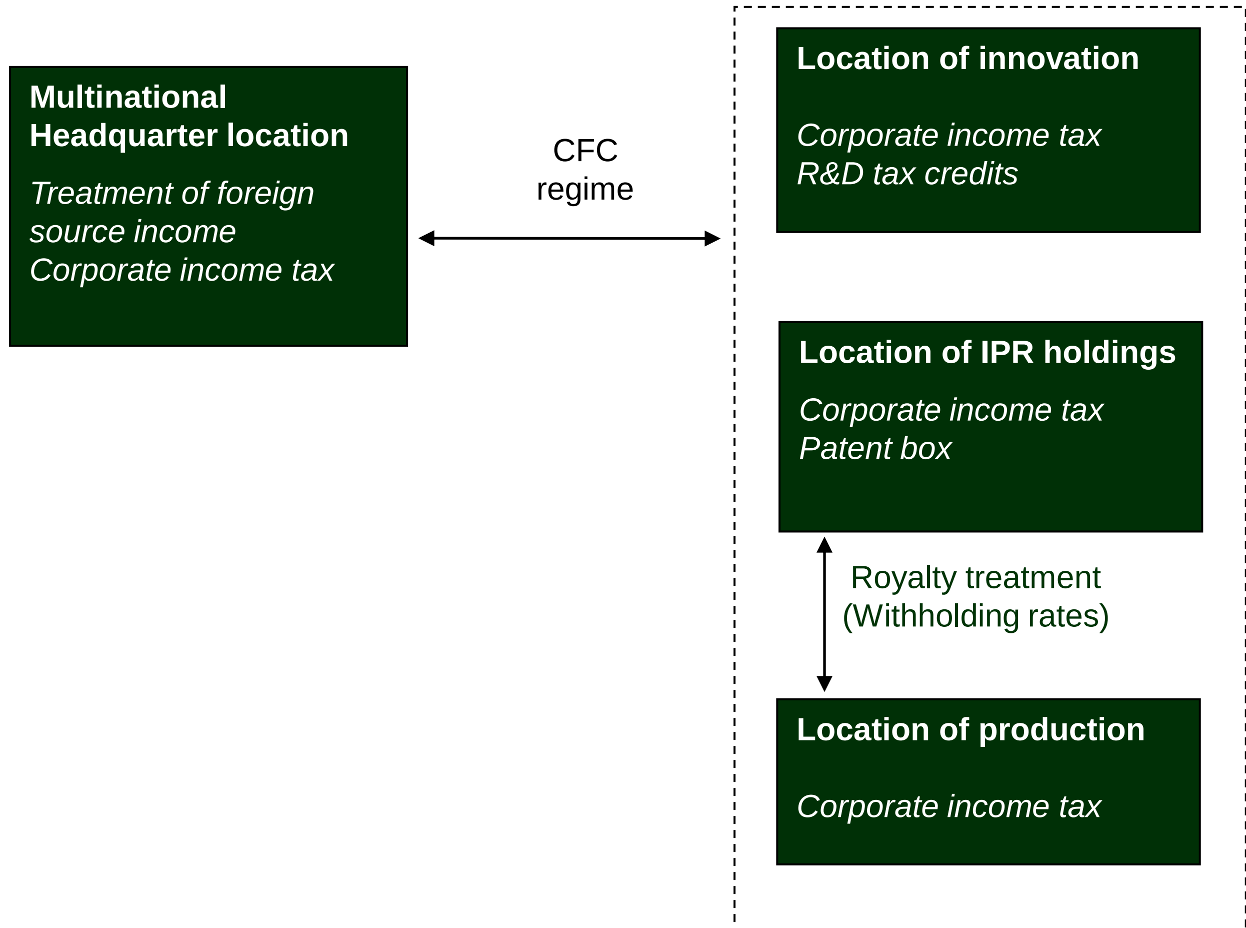
Motivation II – IP and policy

- Many governments want to encourage the creation and use of intangible capital to boost productivity - tax policy is one instrument that governments can use

- Intellectual property has been in policy spot light
  - Controlled Foreign Companies (CFC) regimes
  - Patent Boxes

- Number of important questions:
  - how does tax policy affect the level and location of innovation?
  - are the benefits of innovation contingent on activity being geographically located in the country?
  - how to tax mobile income?

Location and taxes



Policy: Patent Boxes

- Substantially reduced rate of corporation tax for the income derived from patents
- Recently introduced by a number of European countries
  - Belgium 6.8% (full rate, 34%); Netherlands 10% (full rate, 25%); Luxembourg 5.9% (full rate, 39%)
  - UK to introduce in 2013, 10% (full rate, 24% in 2013) at a cost of £1.1bn

Patent Box as an innovation policy

- Original stated aim of UK policy: *"strengthen the incentives to invest in innovative industries and ensure the UK remains an attractive location for innovation"*

- Poorly targeted - targets **income** from ideas, not the activity that generates new ideas

- Research can be located separately from income
  - unclear that attracting IP will also attract innovative activities

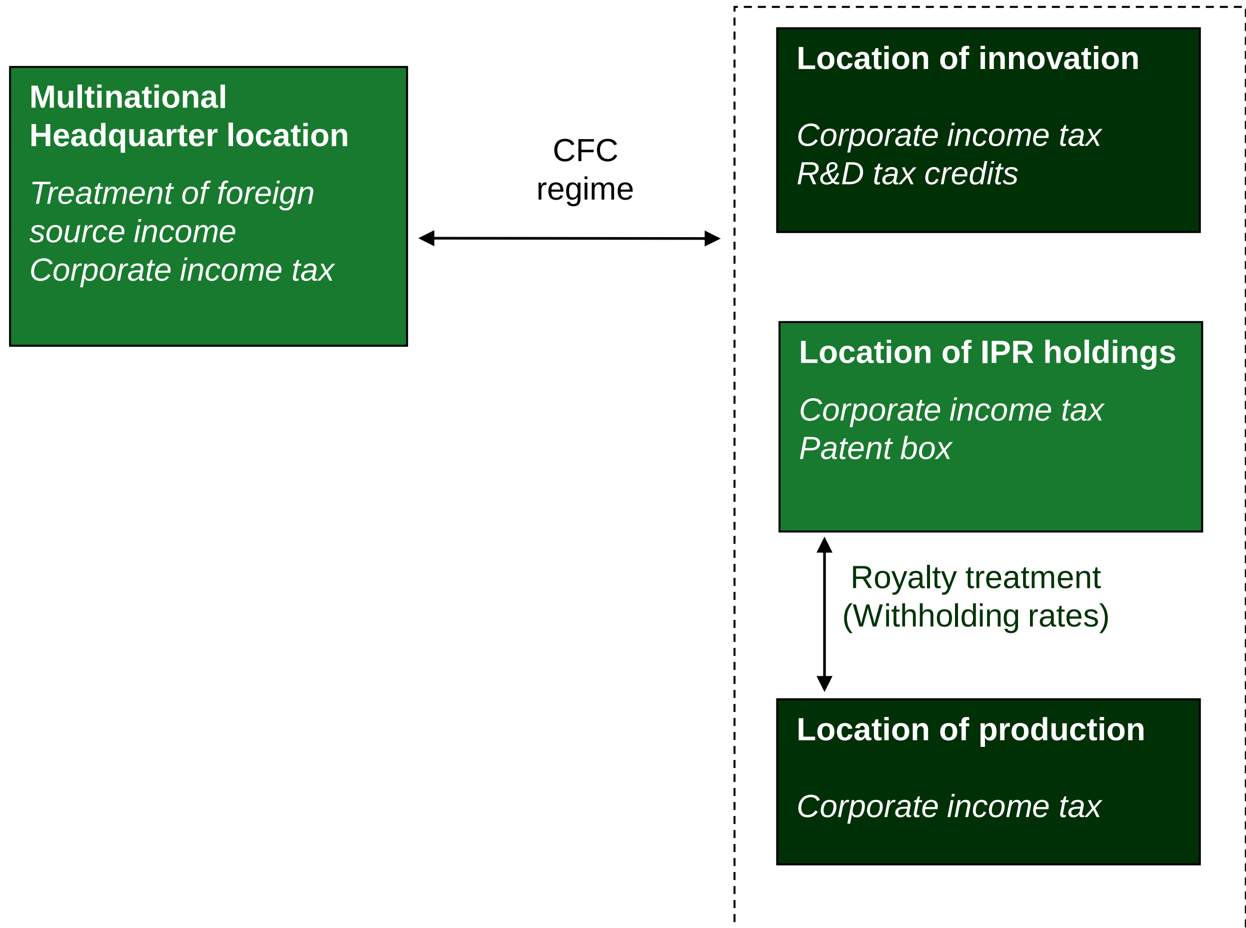
- Large deadweight cost / significant revenue cost / implementation difficulties / benefits accrue to a small number of firms / distorts the decision to invest in patentable technologies

Patent Box as a preferential rate for mobile income

- Preferential rate on an important form of more mobile activities
  - Mirrlees review: *“In principle, it would be efficient to tax rents from relatively immobile activities at a higher rate than rents from more mobile activities”*
  - allow higher rates to persist on less mobile activities

- How responsive is the location of intellectual property to corporate taxes?

Location and taxes



Impact of tax on location of intellectual property

- *Griffith, Miller and O'Connell (2011)* - provide empirical evidence on how responsive the location of IP is to corporate tax

- Model the impact of corporate taxes on innovative European multinationals' choices over where to hold patent applications

- Allow heterogeneity (observed and unobserved) in where patents are located and how responsive such choices are to tax
  - important for predicted patterns of movements across countries

- Simulate the effect of Patent Box

Data

- Multinational firms ownership structure
  - European parent firms and their European and US subsidiaries
  - consider location of patent applications (EPO, 1985-2005)
- Tax data
  - statutory corporate tax rates
  - CFC regime operated in home country

Summary of estimation results

- Firms respond to taxes when choosing where to hold IPR
- Important to account for:
  - interactions between tax jurisdictions
  - observed and unobserved heterogeneity in responsiveness
  - unobserved country effects

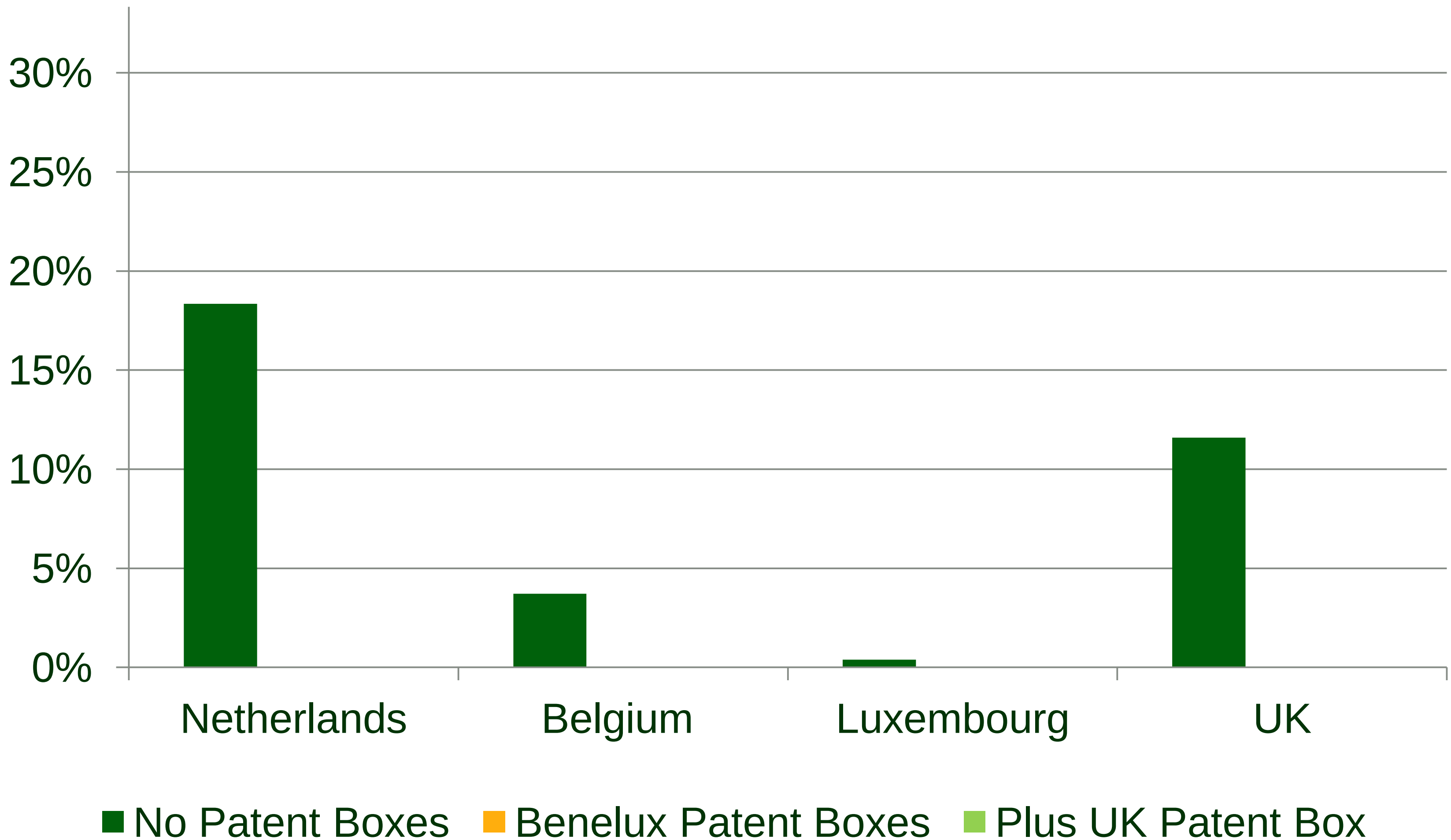
- Size of effect:
  - Own tax elasticities: a ten percentage point fall in the tax rate would increase the share of patent holdings by between 7%-15%
  - Range of cross tax elasticities between pairs of countries, e.g. 10% increase in the Belgium tax rate leads to a 0.5% increase in the share of patents in the UK while the same increase in the French tax rate increase the UK share by 2.6% points.

Counterfactual policy analysis: Patent Boxes

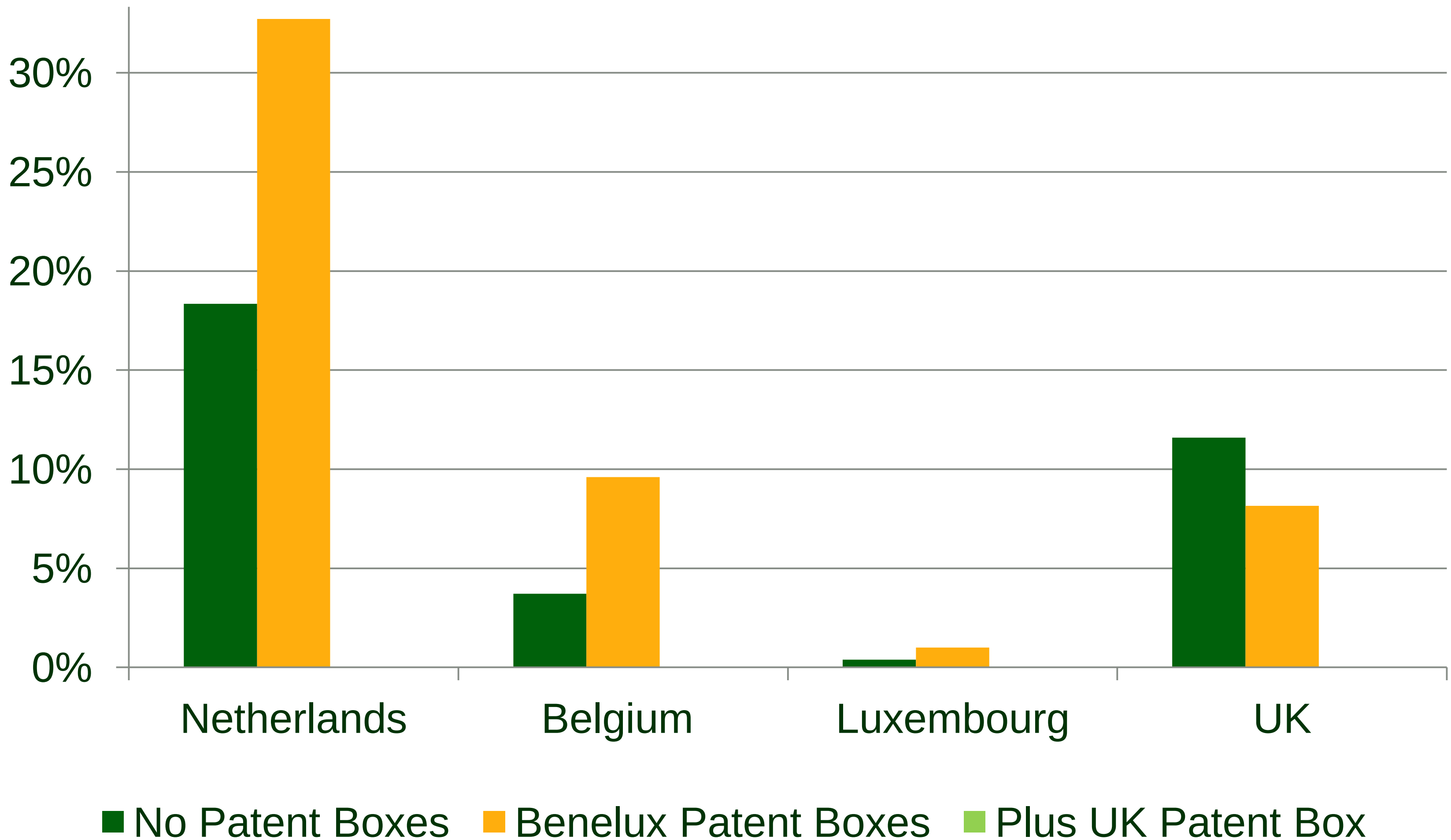
- What is the likely affect of Patent Boxes?
  - how do we expect the location of patents to change when favourable tax regimes are introduced?
  - what effect will this have on tax revenue?

- Don’t observe firms actual behaviour – policies are too recent

Effect of Patent Boxes: share of new patent applications

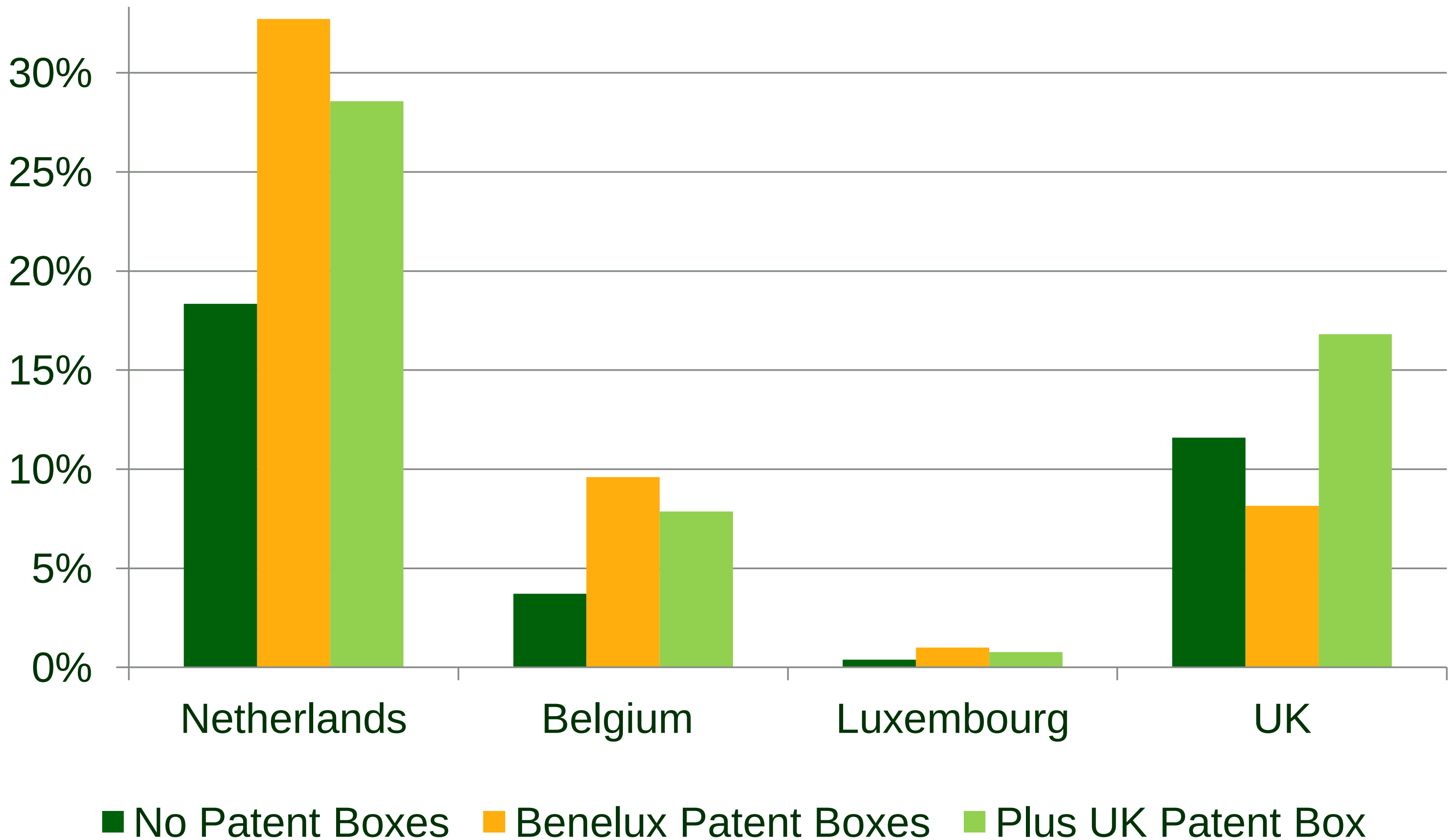


Effect of Patent Boxes: share of new patent applications



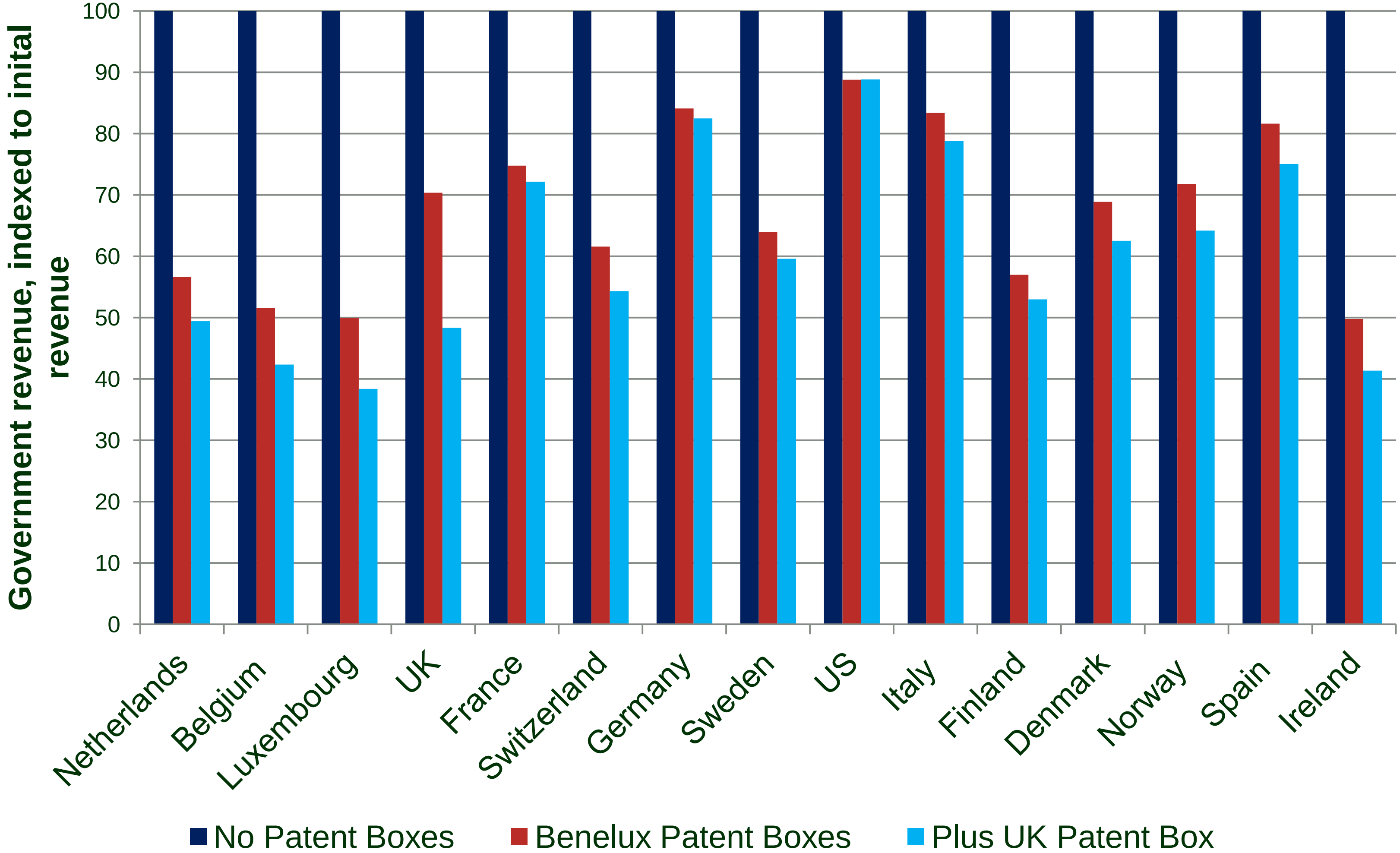
Institute for Fiscal Studies

Effect of Patent Boxes: share of new patent applications



Institute for Fiscal Studies

Tax revenue (indexed to 100 before Patent Boxes)



Government Tax Competition

- We find indicative evidence that tax competition could erode any benefits

- Theoretical results on preferential rates are predicated on underlying assumptions
  - isolate tax competition in one part of the tax system, or
  - leads to no tax on mobile income and lower all revenues for all governments

- Going forward – model government behavior to consider strategic government tax setting
  - write down government's maximisation problem and find optimal policy

Summary and concluding comments

- Governments are grappling with questions of how to tax innovation and the associated income
  - the mobility of income raises additional challenges

- A number of European governments have introduced Patent Boxes

- Patent Boxes are poorly targeted at innovation; the effect of the location of real innovative activities is unclear (but important)

- We find that the location of firms’ patent applications respond to corporate taxes. Patent Boxes attract patent income but also lead to a reduction in government revenues.

OFFICE OF TECHNOLOGY ASSESSMENT

CONGRESS OF THE UNITED STATES

THE EFFECTIVENESS OF RESEARCH AND EXPERIMENTATION TAX CREDITS

I. Introduction and Findings

In 1981 the federal government enacted the research and experimentation (R&E) tax credit, intended to encourage firms to conduct additional research and development.[1] Congress has never made the credit a permanent part of the tax code—instead, it has extended the credit six times, on two occasions (1986 and 1992) after having allowed the credit to expire. On June 30, 1995, the credit expired once again, putting Congress back in the position of deciding whether to extend the credit and, if so, for how long and with what terms. The original justification for making the R&E tax credit temporary was to allow Congress to review the performance of the law before making a decision over its permanence, although the actual reason for avoiding this decision appears to be primarily a matter of Congress' budget scoring process—a permanent credit entails scoring a permanent revenue cost, while the cost of a temporary credit needs to be scored only for the period of extension. Many firms and other observers believe that 15 years has been a more than adequate review period, and that the R&E tax credit's temporary nature has limited its effectiveness because firms cannot include the credit in their long-term R&D budgets.

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[1] The tax credit specifically applies to research and "experimentation," although in practice it is difficult to distinguish that category of activity from the more commonly used " research and development" (R&D). This paper refers to the tax credit using its specific terminology—the R&E tax credit—while referring to research in general terms as "R&D".

In principle, the R&E tax credit addresses an important public policy goal: stimulating private sector R&D spending, and thereby encouraging advancements in scientific and technological knowledge. Technological change catalyzes entirely new industries, transforms existing ones, and consequently represents a fundamental element of economic growth.[2] An entire generation of economic research has shown that technological change enhances productivity growth—for firms, industries, and the economy as a whole—and hence contributes directly to growth in national income and wealth.[3] Moreover, recent research indicates that firms which use advanced technologies tend to have high employment growth rates, high labor skill and wage levels, and high productivity.[4]

Much of the growth in national productivity ultimately derives from research and development (R&D) conducted by private industry.[5] Private enterprise conducts 72 percent of all R&D performed in the United States, compared to 12 percent for academe and 10 percent for the Federal government.[6] In terms of funding, the private sector has become the dominant source of R&D investment, rising from 40 percent of all funding in 1970 to nearly 60 percent by 1994. During this period, government R&D funding decreased from 57 to 36 percent of the total (see figure 1).[7]

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[2] Although economists widely agree that technology is an important component of national economic growth, they have great difficulty measuring the effect precisely due to the large number of complex and inter-related variables that shape economic growth. At a minimum, measures of total factor productivity indicate that technology has accounted for 15 to 20 percent of economic growth over the last 20 years. Other estimates, based on different definitions and encompassing technological spillovers and other ancillary factors, attribute half to nearly all of economic growth to technological change.

[3] For surveys of this literature, see Hall (1994); Nadiri (1993); Griliches (1992); Nadiri (1980); and Mansfield (1972). For a broad overview of the micro and macroeconomic aspects of technological change, see Rosenberg, Landau, and Mowery (1992). It should be noted that, although productivity growth generally increases national welfare, it can also reduce welfare if the resources released by productivity gains do not move into other economically valuable activities.

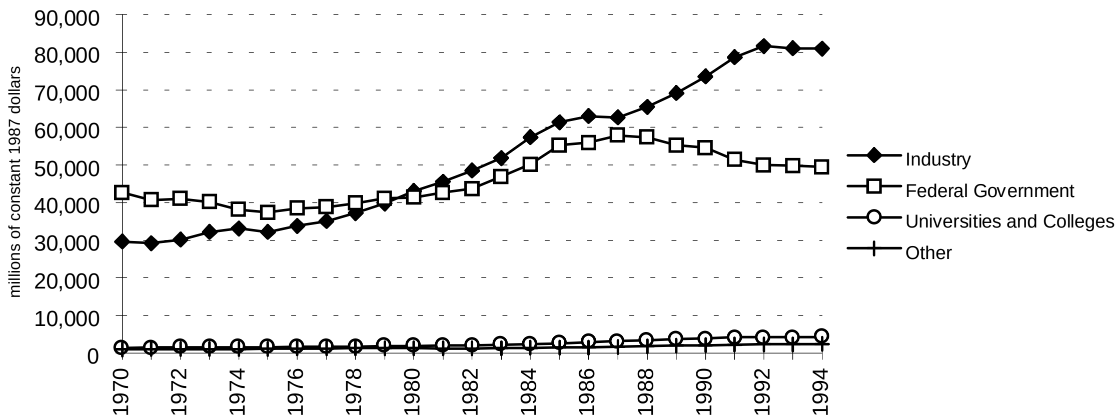
[4] U.S. Department of Commerce, *Technology, Economic Growth, and Employment* (1994).

[5] See Fagerberg (1994); Lichtenberg (1992); and Nelson (1992).

[6] NSF, *National Patterns of R&D Resources* (1994). Figures are for 1994. The distribution of R&D performance has changed slightly over time: business R&D increased from 69 percent of all R&D in 1970 to 74 percent in the mid-`80s, and then declined to 72 percent in 1994; academic R&D stayed relatively constant at 9 percent throughout the `70s and early `80s, at which point it began increasing to reach 12 percent by 1994; and R&D conducted by the Federal government has decreased steadily from 16 percent of all R&D in 1970 to 10 percent in 1994.

[7] Universities and other sources account for only 3 and 2 percent, respectively, of all R&D funding in the United States. NSF (1994).

Figure 1: Real R&D Expenditures in the U.S., by Source of Funds, 1970-1994



Source: NSF, *National Patterns of R&D Resources: 1994*, tables B6, B9, B12.

However, from a societal perspective, firms will tend to underinvest in R&D because they typically cannot appropriate all the benefits of their research. Intellectual property rights, trade secrets, and other mechanisms such as first mover advantages allow firms to capture some, but not all, of the benefits that flow from their investments in new knowledge.[8] Much of the benefit from R&D conducted by individual firms accrues to other firms and society at large, through direct channels such as usable knowledge, new products and services, and reduced prices, as well as through indirect channels such as improved product capabilities and enhanced productivity. For example, advancements in semiconductor technologies have promoted subsequent product and process innovations across numerous industries that use semiconductor devices, ranging from computers and consumer electronics to aerospace and autos. Similarly, innovations in applying advanced computing technologies to production processes have reduced costs and increased productivity across many sectors of the economy. And scientific advancements in the biosciences have expanded the scope of numerous technologies, from pharmacology to agriculture, and brought entirely new types of products into the market.

Since other firms and society at large frequently benefit from the "spillover" of R&D conducted by individual firms, the private rate of return for R&D often is substantially lower than the total return.[9] Estimates from both the firm and industry level indicate that the social rate of return to R&D ranges from 20 to 100 percent, depending

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[8] On appropriability problems in general, see Teece (1992).

[9] The presence of spillovers from private R&D is well established in the literature, although again, the complex and variable nature of these spillovers makes them difficult to measure with precision. See, for instance, Nadiri (1993); Griliches (1992); and Mansfield (1984). Some analysts argue that existing measures of R&D spillovers are entirely inadequate and generally too conservative, since they construe technology too narrowly and fail to capture the varied and subtle ways in which new technologies are diffused and used. See Alic et al. (1992).

on the sector, and averages approximately 50 percent.[10] The channels for R&D spillovers are manifold, including but not limited to intra- and interindustry business relationships, supplier-user relationships, personnel flows, interdependencies between public and private sector investment, and interactions among geographically proximate firms. Moreover, spillover channels are increasingly international, driven largely by the expanding business operations of multinational corporations as well as by various forms of scientific and technological exchange and the cross-border exchange of technologically-intensive goods and services.[11] R&D spillovers, in short, signify a classic market failure: because individual firms cannot appropriate the full benefits of their R&D, society will experience suboptimal levels of investment in the search for new knowledge.

In economic theory, market failures of this magnitude and significance justify governmental action. Yet however persuasive in theory, it is quite difficult in practice to determine when and how the Federal government should seek to mitigate market inefficiencies in research and development. When should the government use direct policy mechanisms (i.e. performing or funding nationally relevant R&D that the market would not provide), and when indirect ones (such as the tax policies and other instruments designed to stimulate R&D investment beyond the level encouraged by the private rate of return)? Under what circumstances are particular incentives most effective? Should most incentives be nondiscriminatory, or should they be channeled to those types of R&D and/or business activities that exhibit particularly high social rates of return?

Many analysts agree that the R&E tax credit is, in principle, a sensible policy instrument for encouraging the private sector to supply a more socially optimal level of R&D investment.[12] By design, the R&E tax credit has the advantage of being relatively straightforward and nondiscriminatory—it is oriented toward high technology firms with an expanding ratio of R&D to sales, and beyond that it does not necessarily favor particular firms or technologies, nor does it otherwise interfere with the allocation of research and development resources in the private sector. In practice, however, the R&E tax credit often has been criticized for being indefinite in duration and unwieldy in form,

[10] By comparison, the net private rate of return to R&D varies from 20 to 30 percent. See Nadiri (1993). The distribution and magnitude of private and social rates of return to R&D vary widely by sector and across time. Generally, spillovers are most prevalent in R&D intensive industries, although estimates of the rate of return as well as the price sensitivity for R&D depend upon the type of data and methods used. On sectoral variations, see Bernstein and Nadiri (1988); and Hall (1993b).

[11] The extent of international R&D spillovers has been a matter of debate. Some studies indicate that R&D spillovers remain relatively localized (see Jaffe et al. (1993)); others indicate that international spillovers occur but are much more significant for small countries than for large ones (see Coe and Helpman (1993)). As with domestic R&D, it is intrinsically difficult to measure international R&D externalities; nevertheless, it is reasonable to expect that contemporary business practices and trends expand the potential for technology transfer and diffusion within and across borders. See U.S. Congress, OTA (1994).

[12] See, for example, Hall (1993), Baily and Lawrence (1987), Bozeman and Link (1984), Collins (1982, especially Mansfield and Nadiri in that volume), Penner, Smith, and Skanderson (1994) among authors that explicitly discuss the tax credit as a policy tool.

for excluding certain types of R&D-performing firms, and for possibly subsidizing research that would take place regardless of the credit. Existing studies of the R&E tax credit are informative in many respects but, as this report demonstrates, are dated, less than comprehensive, or otherwise unsatisfactory.[13]

This background paper is designed to provide Congress with a full review of the available evidence regarding the effectiveness of the credit in spurring private sector R&D, as well as to consider additional information on the practical efficiency of the credit both on its own terms and relative to other policy measures. The study was requested by Senator Orrin Hatch, who chairs the Taxation Subcommittee of the Senate Committee on Finance, and Congresswoman Constance Morella, who chairs the Technology Subcommittee of the House Science Committee.

To clarify the fundamental issues at stake and properly design the research project, OTA convened a panel of experts on the R&E tax credit on July 19, 1995. Panelists reviewed a contractor report prepared for OTA by Bronwyn Hall, and debated a range of issues central to Congressional interest in the topic. This background paper builds upon OTA's contractor report and subsequent critiques, the OTA workshop proceedings, and OTA staff research, including extensive interviews with senior corporate executives responsible for R&D, financial planning, and taxation, as well as discussions with IRS officials, tax lawyers, and tax accountants that specialize in the research and experimentation tax credit. OTA has used these sources of information to assess how well the R&E tax credit is currently understood, identify inadequacies in the existing data and analyses, investigate implementation issues, consider the tax credit in the context of corporate R&D trends and Federal R&D policy more broadly, draw appropriate international comparisons, and specify important avenues for further research.[14]

The analysis conducted by OTA and presented in this background paper supports the following findings:

Findings

- A complete cost-benefit assessment of the R&E tax credit requires information that has not been collected and may be either unavailable or impossible to estimate accurately. On the benefit side of the equation, the return to society of the R&E spurred by

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[13] See, for example, McFetridge and Warda (1983), Brown (1985), Cordes (1989), Penner, Smith, and Skanderson (1994), Harhoff (1994), Warda (1994), and Dumagan (1995).

[14] As explained in this report, current knowledge of the R&E tax credit is insufficient in many respects, and requires new research based on econometric models using IRS tax data as well as survey and interview data. OTA originally planned to conduct this research during the Fall and Winter of 1996, and to provide Congress with final results and a discussion of their policy implications in early Spring 1997. However, OTA will not be able to complete this research due to inadequate Congressional funding for OTA in fiscal year 1996.

the credit cannot be estimated for two fundamental reasons—first, there is no way to measure precisely how much or especially what kind of R&D is induced by the credit; and second, measuring the social rate of return to R&D is intrinsically difficult. On the cost side, there is no way to estimate how much R&D would have taken place in the absence of the credit, nor is much known about the size and significance of administrative costs for either the government or firms.

- Most evaluations of the tax credit assume that there are important spillovers to private sector R&D, and assess the credit simply in terms of whether it generates additional R&D spending. The best and most recent available studies use econometric techniques to estimate the amount of R&E induced by the tax credit. Using firm-level publicly-reported R&D data, these studies generally indicate that for every dollar lost in tax revenue, the R&E tax credit produces a dollar increase in reported R&D spending, on the margin. Based on this criterion and evidence, the R&E tax credit appears to be an effective policy instrument. It is logical to expect that the private sector response would be improved if the credit were made permanent, although it is difficult to predict the magnitude and significance of the effect.

- Current econometric studies do contain data and methodological uncertainties. Among other concerns, the estimated 1:1 sensitivity of R&D spending to the R&D tax rate (e.g., if the tax credit reduces the cost or “price” of R&D by one dollar, R&D spending will increase by one dollar) is considerably higher than estimates of the overall sensitivity of R&D spending to general changes in R&D costs, which range from 0.3 to 0.5:1 (which is to say that a one dollar reduction in the cost of R&D will increase R&D spending by 30 to 50 cents). Researchers cannot easily explain why these two R&D price sensitivity measures differ. Possible reasons include measurement and methodological differences, differences in the time periods used to develop the estimates, or an over-estimation of the tax price of R&D due to the "re-labeling" effect (e.g. estimates of tax-induced spending increases may include pre-existing R&D expenditures that were re-categorized to conform to the tax definition of R&D).

- In 1992 (the most recent available data), the IRS reported that firms filed for nearly $1.6 billion in research and experimentation tax credits, although the dollar value of the credits actually received by firms remains unknown due to several complicating factors that, in all likelihood, reduce the actual tax subsidy provided to firms. Since the policy began, most of the R&E tax credit has been claimed by manufacturing firms, which accounted for three-fourths of the total credit claimed in 1992. Most of the firms that do claim the R&E tax credit are large—in 1992, firms with over $250 million in assets claimed 70 percent of the credit; firms with assets between $10 and $250 million claimed about 19 percent, while firms with $10 million or less in assets claimed approximately 11 percent of the credit. Access to the R&E tax credit varies significantly across firms, due to factors such as variations in tax status, different R&D and sales trajectories, business cycle fluctuations, the type of R&D involved, and whether projects involve either collaborative partners or outside contractors.

- Evidence obtained through OTA interviews and other sources indicates that the R&E tax credit affects firms at the level of general budget considerations, not at the level of strategic R&D choices. Some firms may rely heavily on the credit, as is often the case in industries with rapidly expanding R&D outlays (such as biotechnology and communications) or for firms that have particularly stringent growth strategies. Generally, however, R&D strategies derive from fundamental business and technological objectives, with little or no consideration given to the R&E tax credit per se. In essence, the R&E tax credit represents more of a financial tool than a technology tool.

- There does not seem to be any correlation between the R&E tax credit and the total level of R&D spending in the United States. The credit never has represented a significant portion of total non-Federal funds for corporate R&D—the R&E tax credit peaked at 3.1 percent of industry R&D funds in 1984, and from then it decreased steadily to 1.6 percent of non-Federal industry R&D funds in 1992. Similarly, the credit accounts for only a small percentage of total R&D investment at the level of individual industries. Consequently, the R&E tax credit is unlikely to have a substantial competitive effect on aggregate R&D spending. At the level of individual firms, the R&E tax credit may be much more salient, especially for liquidity-strapped firms, firms on very rapid R&D growth trajectories (as in the communications and information technology industries), and firms whose R&D performance strongly affects their market valuation (biotechnology, for example).

- The R&D tax credit also represents a small fraction of Federal R&D expenditures (2.6 percent of total Federal R&D funding and 6.4 percent of Federal R&D funds for industry). Although indirect incentives like the tax credit often are compared with direct funding mechanisms, the two types of policies perform very different functions. If the policy goal is to increase private sector R&D at the margin, with little or no impact on the allocation of R&D resources across different technologies or types of research, then the R&E tax credit may be an appropriate and relatively effective policy instrument. If the policy goal is to rectify the market's tendency to undersupply basic research or some other particular types of technologies, such as infrastructural or "generic" research, then the R&E tax credit may be relatively ineffective because it does not substantially alter the allocation of R&D resources across different research activities. Policy choices regarding the use and coordination of different R&D subsidy instruments undoubtedly would benefit from further research into the social rate of return to different forms of public and private R&D, as well as into the extent and nature of R&D market failures in the United States.

I

INVESTING IN U.S. COMPETITIVENESS:

The Benefits of Enhancing the Research and Experimentation (R&E) Tax Credit

"Instead of tax loopholes that incentivize investment in overseas jobs, I'm proposing a more generous, permanent extension of the tax credit that goes to companies for all the research and innovation they do ... right here in the United States of America."

– President Barack Obama, September 8, 2010

UNITED STATES DEPARTMENT OF THE TREASURY
A Report from the Office of Tax Policy
March 25, 2011

Executive Summary

The Administration's proposal to enhance the Research & Experimentation tax credit will:

- **Leverage More Than $100 Billion in Domestic Private-Sector Research over the Next 10 Years.**
- **Support Nearly 1 Million Research Workers in the U.S. in Professions that Pay Higher-Than-Average Wages.**
- **Increase the Total Amount of the Credit by 20 Percent.**
- **Increase Use of the Simpler Version of the Credit.**
- **Strengthen the Incentive Effect of the Credit by Providing Certainty to Taxpayers.**

The Research & Experimentation (R&E) tax credit encourages innovation and provides a powerful incentive for businesses to continue to invest in research projects. Investments in research and experimentation produce technological advancements that drive productivity growth and improvements in U.S. living standards. Businesses may underinvest in research, however, because they may not be able to capture the full benefit of their spending. The R&E tax credit is designed to address this underinvestment and to increase the total amount of research activity undertaken in the United States.

The credit has been extended on a temporary basis 14 times since its creation in 1981, often retroactively, and is currently scheduled to expire on December 31, 2011. When the credit lapses, the incentive effect is blunted because uncertainty about whether the credit will be available in the future makes it difficult for taxpayers to factor the credit into decisions to invest in research projects that will not be completed prior to the credit's expiration. That is why the President proposed making the R&E credit permanent in his Fiscal Year (FY) 2010 and 2011 budgets and extended the current credit through 2011 as part of the bipartisan tax agreement in December 2010.

Two years ago, the President set an ambitious goal of achieving a level of research and development that is the highest share of the economy since the space race of the 1960s – 3 percent of GDP – a commitment he re-emphasized in his State of the Union address in 2011. The R&E tax credit is a vital component of achieving this goal and helping us out-innovate our competition. This is why, in addition to making it permanent, the President proposed on September 8, 2010 to expand and simplify the credit, making it easier and more attractive for businesses to claim this credit for their research investments. This proposal was subsequently included in the President's FY 2012 Budget and should be part of the reform of our corporate tax system currently under consideration.

Benefits of the Current Research & Experimentation Credit

In its current form, the R&E credit provides:

- **A Cost-Effective Way to Encourage Research Spending.** Recent studies show that the credit produces approximately a dollar for dollar increase in current research spending and that this amount could be larger in the longer run.
- **Nearly $9 Billion in Annual Tax Credits for Research.** In Tax Year 2008, the most recent year for which corporate tax return data are available, 12,736 corporations claimed $8.3 billion in research credits and more than 64,000 individual taxpayers claimed $463 million in research credits.
- **Support for High-Wage Jobs.** Approximately 70 percent of research costs that qualify for the credit are labor costs, indicating that the R&E tax credit provides valuable support for these high-tech jobs. Much of the research that takes place in the United States is done by highly skilled employees, who earn higher than average wages. According to the National Science Foundation, in 2008 the average annual wage for individuals in science and technology occupations was about $74,950, compared to $42,270 for all occupations.

The Administration's Proposal to Expand, Simplify, and Make Permanent the R&E Credit

The Administration's proposal to enhance the R&E credit and make it permanent will:

- **Leverage More Than $100 Billion in Domestic Private-Sector Research over the Next 10 Years.** The Administration's proposal to expand the credit and make it permanent will provide approximately $106 billion in credits from Fiscal Year 2012 through Fiscal Year 2021. Given that research shows the credit produces a dollar for dollar increase in research spending in the short run, the expectation is that a permanent credit would result in at least an equal increase in private-sector research spending over the next decade, all of which will occur in the United States. Research also suggests that the long-run impact of the credit could be even greater.
- **Support Nearly 1 Million Research Workers in the U.S.** The Administration's proposal for a permanent and enhanced R&E tax credit will provide an incentive for undertaking research activity in the United States. Companies receiving the credit employ nearly 1 million domestic workers conducting research.
- **Increase the Total Amount of the Credit by 20 Percent.** The Administration's proposal to increase the rate of the alternative simplified R&E tax credit from 14 percent to 17 percent will enhance the incentive to increase research activity.
- **Increase Use of the Simpler Version of the Credit.** Expanding the alternative simplified credit will make it more appealing and encourage more companies to choose the simpler version of the credit.
- **Strengthen the Credit's Incentive Effect.** A permanent R&E tax credit would improve its incentive effect by providing businesses with certainty that they can make investments in long-term research projects and benefit from the credit over the course of the project.

Introduction

Investments in research and experimentation produce the technological advancements that are an important determinant of productivity growth and improvements in U.S. living standards.[1] A large and growing body of evidence suggests that investments in research are associated with future gains in market value and profitability at the firm level, and with increased productivity at the firm, industry, and economy-wide levels.[2] Moreover, this body of evidence demonstrates that there are important spillover effects from research investments: research activities undertaken by one firm can increase the productivity and market value of firms in related fields. Businesses invest in research because of the possibility of reaping profits from new products and processes. However, businesses may not be able to capture the full benefits of their research spending because the knowledge it produces may be used by other businesses. As a result, the private sector may not make some investments in research that would benefit society as a whole.[3] That is why we need incentives such as the R&E tax credit – to address the underinvestment in research by businesses and thereby increase the total amount of research activity undertaken in the United States.[4]

The R&E tax credit creates an incentive to undertake research by providing a tax credit based on qualified research expenses.[5] The Internal Revenue Code defines credit eligibility in terms of the types of activities and expenses that qualify.[6] The credit, which originally was enacted under the Economic Recovery Tax Act of 1981, is designed to encourage businesses to increase their investment in research by rewarding an increase in research spending compared to prior levels. Subsidizing this activity through the tax system is a market-based response for addressing the underinvestment in research (from a society-wide perspective), because the private sector, rather than the government, chooses the research projects and the method for conducting the research.

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[1] The link between research and productivity growth is discussed in The Congressional Budget Office, "R&D and Productivity Growth," Background Paper, June, 2005.

[2] See The Economic Report of the President, February 2011, for a discussion of the link between innovation and economic growth.

[3] A recent review of the literature on the return to research and development (R&D) concluded that the returns to R&D are positive in many countries and usually higher than those to ordinary capital. Moreover, social returns to R&D are almost always estimated to be substantially greater than private returns. See Bronwyn H. Hall, Jacques Mairesse and Pierre Mohhnen, "Measuring the Returns to R&D," NBER Working Paper 15622, December, 2009, at http://www.nber.org/papers/w15622. See also Nicholas Bloom, Mark Schankerman, and John Van Reenen, "Identifying Technology Spillovers and Product Market Rivalry", working paper, August 2010.

[4] The government also uses other policy tools to address underinvestment in research from society's perspective, such as direct spending and grants for both basic and applied research and the protection of intellectual property rights through the patent system.

[5] In addition, research expenses can be deducted in computing taxable income in the year they are paid or incurred, notwithstanding the general rule that business expenses to develop or create an asset that has a useful life extending beyond the current year must be capitalized. The deduction for research expenses is reduced by the amount of research credit claimed by the taxpayer for the taxable year or the taxpayer can elect to reduce the amount of research credit claimed.

[6] See the Appendix for more details.

Effectiveness of the R&E Credit

One of the most important considerations regarding the use of tax incentives for research is their effectiveness at increasing the overall amount of research activity. Evaluations of the effectiveness of the R&E credit generally compare the amount of research induced by the credit to the loss in tax revenue. If the ratio is greater than one, the credit is viewed as a cost-effective way to provide a subsidy to research; if it is less than one, funding the research directly would have been more cost effective.[7]

Early studies of the responsiveness of research spending to price reductions (the price elasticity) found that the price elasticity for research was substantially less than one, generally in the range of -0.2 to -0.5, implying that a one percent reduction in the price of research would eventually lead to an increase in spending between 0.2 percent and 0.5 percent.[8] However, more recent research suggests a stronger behavioral response. Recent estimates indicate that the tax price elasticity for research spending is around -1. This means that the research credit produces a dollar for dollar increase in research spending, although some studies find larger effects.[9] Thus, the research credit appears to be cost effective from a budgetary perspective, especially when the social return to investment is factored in. Moreover, recent studies have found that tax incentives may have a larger effect on research spending in the longer run than in the short run, presumably because research spending takes time to adjust to changes in the cost structure.

An explanation for the modest behavioral effects found in early studies of the credit may reflect the fact that it took time for taxpayers to learn about the credit and the expenditures that qualified. In addition, it likely took time for businesses to incorporate the existence of the credit into their decision-making related to R&E investments. This is consistent with the intuitive notion that tax provisions become more salient to decision makers the longer they are in effect.

The overall effectiveness of the current credit may be negatively affected by the fact that it has been perceived as temporary, which makes it difficult for firms to factor in its effect on long-term research projects and research projects with long lead times. The R&E credit has been extended by Congress 14 times since its creation in 1981, often retroactively, and was allowed to lapse for a period (between June 30, 1995 and July 1, 1996) without retroactive application upon reinstatement. The credit is currently scheduled to expire on December 31, 2011. When the credit lapses for a

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[7] Ideally, the credit's effectiveness would be measured by whether the activity it encouraged is more beneficial to society than the activities discouraged by the additional resources (e.g., taxes) used to fund the credit.
[8] See GAO, "The Research Tax Credit Has Stimulated Some Additional Research Spending", GAO/GGD-89-114, September 1989.
[9] Recent surveys include Bronwyn Hall and John Van Reenen, "How Effective Are Fiscal Incentives for R&D? A Review of the Evidence," *Research Policy*, Vol. 29, 2000 and Robert D. Atkinson, "Expanding the R&E Credit to Drive Innovation, Competitiveness, and Prosperity", *Journal of Technology Transfer*, Vol. 32, 2007.

period of time, the incentive effect is blunted because of the uncertainty about whether the credit will be available in the future.

Use of the Credit

In Tax Year 2008, the most recent year for which corporate tax return data are available, 12,736 corporations claimed $8.3 billion in research credits.[10] In addition, 64,000 individual taxpayers claimed $463 million in research credits.

Table 1 shows the amount of the credit claimed by corporations in Tax Year 2008 by industry sector. It shows that corporations in the manufacturing sector accounted for about 43 percent of all corporations claiming the credit. Those manufacturers claimed almost 69 percent of the total dollar amount of credits.

Table 1. Corporations Claiming Research and Experimentation Tax Credit: Tax Year 2008

Industry	Number of Returns	R&E Credits Claimed [$1000s]	Number of Returns as Percent of Total	Amount Claimed as Percent of Total
All Industries	12,736	8,303,369	100.0%	100.0%
Manufacturing	5,420	5,758,082	42.6%	69.3%
Information	1,132	944,284	8.9%	11.4%
Professional, scientific, and technical services	3,932	787,671	30.9%	9.5%
Wholesale and retail trade	865	430,098	6.8%	5.2%
Finance and insurance	237	142,599	1.9%	1.7%
Management of companies (holding companies)	276	62,091	2.2%	0.7%
Utilities	129	48,855	1.0%	0.6%
Various services	194	43,942	1.5%	0.5%
Mining	36	29,997	0.3%	0.4%
Administrative/ Support & waste mgmt. services	288	22,373	2.3%	0.3%
Transportation and warehousing	58	10,593	0.5%	0.1%
Construction	56	10,278	0.4%	0.1%
Real estate, rental, and leasing	30	7,453	0.2%	0.1%
Agriculture, forestry, fishing, and hunting	83	5,054	0.7%	0.1%

Source: Internal Revenue Service at http://www.irs.gov/taxstats/article/0,,id=164402,00.html

[10] Corporations included in this count are C corporations, i.e., corporations subject to an entity level tax. Tax credits earned by corporations that are not subject to an entity level tax, such as S corporations, flow through to their shareholders and are claimed on the shareholder's individual income tax return. The same is true for tax credits earned by partnerships, which flow through to the partners.

Table 2 shows that within the manufacturing sector, three subsectors – computer and electronic product manufacturing, chemical manufacturing (including pharmaceuticals), and transportation equipment manufacturing – accounted for 78 percent of the total amount of R&E credits claimed by the manufacturing sector.

Table 2. Manufacturing Corporations Claiming the R&E Tax Credit: Tax Year 2008

Industry	Number of Returns	R&E Credits Claimed [$1000s]	Number of Returns as Percent of Total	Amount Claimed as Percent of Total
All Manufacturing	5,420	5,758,082	100.0%	100.0%
Computer and electronic product manufacturing	1,319	1,812,225	24.3%	31.5%
Chemical manufacturing	701	1,489,383	12.9%	25.9%
Transportation equipment manufacturing	291	1,180,968	5.4%	20.5%
Machinery manufacturing	651	339,851	12.0%	5.9%
Miscellaneous manufacturing	575	279,958	10.6%	4.9%
Electrical equipment, appliance, and component manufacturing	555	217,724	10.2%	3.8%
Petroleum and coal products manufacturing	40	99,858	0.7%	1.7%
Food manufacturing	163	80,719	3.0%	1.4%
Fabricated metal product manufacturing	457	74,863	8.4%	1.3%
Paper manufacturing	58	64,226	1.1%	1.1%
Primary metal manufacturing	116	32,098	2.1%	0.6%
Plastics and rubber manufacturing	202	31,366	3.7%	0.5%
Beverage and tobacco product manufacturing	18	12,844	0.3%	0.2%
Nonmetallic mineral product manufacturing	70	12,283	1.3%	0.2%
Furniture and related product manufacturing	70	11,240	1.3%	0.2%
Textile mills and textile product mills	22	5,249	0.4%	0.1%
Wood product manufacturing	14	5,016	0.3%	0.1%
Printing and related support activities	38	4,417	0.7%	0.1%
Apparel manufacturing	55	2,315	1.0%	0.0%
Leather and allied product manufacturing	6	1,478	0.1%	0.0%

Source: Internal Revenue Service at http://www.irs.gov/taxstats/article/0,,id=164402,00.html

Much of the research that takes place in the United States is done by highly skilled employees, who earn higher than average wages. According to the National Science Foundation, in 2008 the average annual wage for individuals in the science and technology occupations was about

$74,950, compared to $42,270 for all occupations.[11] Moreover, approximately 70 percent of qualified research costs are labor costs, indicating that the R&E credit provides valuable support for these high-tech jobs.

Considerations that May Limit the Effectiveness of the Credit in the Past

Uncertainty about the credit's temporary nature and the complexity of calculating it have potentially limited the incentive effect of the R&E credit. These both are areas that the Administration's proposal seeks to address.

1. Uncertainty Caused by the Credit's Temporary Status

As noted above, while still effective, the ability of the current credit to stimulate research may be diminished by the fact that it has been perceived as temporary, which makes it difficult for businesses to factor in its effect when planning research projects. The pattern of an off-and-on tax credit for research increases the uncertainty that firms face about the ultimate after-tax costs they will pay for research activity. This uncertainty can have a negative effect on the total amount and composition of research activity, which is by its nature a highly uncertain investment. The temporary nature of the credit may especially reduce the incentive it provides for the kinds of projects that are long term and require continuing expenditures over many years. For such projects, uncertainty about whether the credit will be available increases the financial risk of the project and weakens the investment incentive. Moreover, many projects have long planning stages, further complicating a company's analysis.

2. Complexity of Credit Calculation

The concept of a tax credit tied to increases in research activity enjoys widespread support, but the credit's design adds a layer of complexity to claiming it. The research and experimentation credit was designed to be an incremental tax subsidy, meaning that firms earn a credit only for their research expenses that exceed a defined base amount.[12] The purpose of this design is to target the tax benefit to research that would not have been undertaken absent the credit. Incremental credits can be more effective per dollar of revenue cost in achieving that goal than "flat" credits, i.e., credits offered at a fixed rate on every dollar of qualified research spending.

[11] National Science Board, Science and Engineering Indicators 2010, Table 3-15, referenced at http://www.nsf.gov/statistics/seind10/pdf/seind10.pdf.

[12] The credit available for energy research is an exception. It applies to all qualified energy research spending, that is, the credit is not incremental and there is no base amount.

Currently, a business must choose between two alternative formulas for calculating its R&E credit: an outdated formula that provides a 20 percent credit rate for research spending over a certain base amount related to the firm's historical research intensity, and a much simpler formula that provides a 14 percent credit in excess of a base amount reflecting its recent research spending.[13] As noted above, the rationale for having a base amount is to approximate what a firm might have spent on research in the absence of the credit.

More specifically, the "regular" research credit is 20 percent of qualified research expenses above a base amount that is the product of the taxpayer's "fixed base percentage" and the average of the taxpayer's gross receipts for the four preceding years. The taxpayer's fixed base percentage generally is the ratio of its research expenses to gross receipts for the years 1984 to 1988. The base amount cannot be less than 50 percent of the taxpayer's qualified research expenses for the taxable year.

The regular credit formula, which determines the base amount with reference to the firm's research intensity (the ratio of its research spending to gross receipts) in the 1984 to 1988 period, clearly is outdated. There is little reason to believe that the firm's ratio of research spending to gross receipts from more than two decades ago, when multiplied by its average gross receipts over the prior four years, is an appropriate base for the taxpayer. In the context of a permanent R&E credit, that base amount will become increasingly irrelevant and arbitrary.

Further, this outdated formula creates complexity for taxpayers. For example, taxpayers that have sold or acquired businesses may have difficulty substantiating and documenting credit claims because the credit's structure relies on a taxpayer's research expenditures and gross receipts for the period from 1984-1988. As time passes, it becomes more difficult for firms to acquire accurate data for that period, particularly in response to changes in the interpretation and application of the statutory requirements. Thus, the regular credit creates compliance challenges for taxpayers and enforcement challenges for the Internal Revenue Service (IRS).

Taxpayers can elect the alternative simplified research credit (ASC), which is equal to 14 percent of qualified research expenses that exceed 50 percent of the average qualified research expenses for the three preceding taxable years. The simplified credit uses a base amount that more appropriately tracks the firm's recent research experience since the credit is available for research expenses that exceed 50 percent of the firm's average research spending for the prior three years.

[13] The R&E tax credit also provides a credit for 20 percent of basic research payments in excess of a base amount and payments to an energy research consortium for energy research.

The advantage of this base is that it is updated annually and thus more accurately reflects the current state of a firm's operations.[14]

The Administration's Proposal to Enhance the R&E Credit

The President has proposed to enhance the R&E credit by:

- **Making the R&E Credit Permanent.** The President proposed in his FY 2012 Budget to permanently extend the R&E credit so that businesses can make investments in research projects, confident that they can benefit from the credit in the future. The President has placed a high priority on making the credit permanent, proposing this in his previous two budgets as well.

- **Increasing the Alternative Simplified Credit Rate by More than 20 Percent.** While the President has previously proposed making the R&E credit permanent, the Administration now also proposes to increase the rate of the alternative simplified credit from 14 percent to 17 percent. This will provide a larger incentive to increase research and simplify the credit by encouraging firms to switch to the alternative simplified tax credit base. The Administration's proposal maintains the current regular research credit to prevent disruption to firms that choose to continue claiming the regular research credit.

This proposal is estimated to provide approximately $106 billion in tax credits for FY 2012 through FY 2021. The expectation is that this enhanced and permanent credit will fund more than $10 billion per year in research activity in the United States, supporting nearly 1 million jobs in research.

To understand how these changes might impact a company, consider a hypothetical large manufacturing corporation that has average qualified research expenses of $460 million for 2009 through 2011 and is considering whether to make research expenditures of $700 million in 2012.[15] Assume that the corporation has $9 billion in average gross receipts for 2009 through 2011, that its fixed base percentage is 4.1 percent, and that it claims the regular research credit instead of the alternative incremental credit. Table 4 shows that under those assumptions, the corporation would earn $66 million under either the regular research credit or the alternative simplified credit under current law if it made $700 million in research expenditures in 2012. However, under the Administration's proposal – as Table 4 shows – the corporation could receive a credit of $80 million by electing the alternative credit (line 9), an increase of $14 million (line 10).

[14] Under the ASC, the rate is reduced to 6 percent if a taxpayer has no qualified research expenses in any one of the three preceding taxable years.

[15] This example assumes that the R&E credit is in effect in 2012.

In these examples, the Administration's proposal would provide an incentive to increase research spending by reducing the after-tax cost of the research.

Table 4. Computation of the R&E Tax Credit

		$ millions
Qualified research expenses:		
1	Wages	500
2	Supplies	180
3	Eligible contract research expenses	20
4	Total qualified research expenses (line 1 +line 2 + line 3)	700
Alternative Simplified Credit (ASC):		
5	Average research expenses for the prior 3 years	460
6	Base amount (.5 x line 5)	230
7	Qualified research expenses in excess of base amount (line 4 - line 6)	470
8	ASC credit under current law (.14 x line 7)[a]	66
9	ASC credit under FY 2012 Budget proposal (.17 x line 7)[a]	80
10	Increase in the credit (line 9 - line 8)	14
Regular Research Credit:		
11	Average gross receipts for the prior 3 years	9,000
12	Ratio of research expenses to gross receipts for 1984 through 1988	0.041
13	Base amount[b]	369
14	Qualified research expenses in excess of base amount (line 4 - line 13)	331
15	Regular credit under current law (.2 x line 14)[c]	66

a Taxpayers have the option of reducing the deduction for research expenses by the amount of the credit or reducing the amount of the credit by 65% of the amount otherwise allowed. In this example, the reduced credits would be $43 million under current law and $52 million under the proposal.

b The base amount cannot be less than 50% of total qualified research expenses.

c Taxpayers have the option of reducing the deduction for research expenses by the amount of the credit or reducing the credit rate to 13% (65% of 20%). In this example, the reduced regular credit would be $43 million.

Conclusion

The R&E tax credit encourages technological developments that are an important component of economic growth. Recent studies show that the credit produces approximately a dollar for dollar increase in current research spending and that this amount could be larger in the longer run. Thus, this research shows that the R&E credit is a cost-effective way to encourage research.

However, uncertainty about the future availability of the credit diminishes its incentive effect because it is difficult for taxpayers to factor the credit into decisions to invest in research projects that will not be initiated and completed prior to the credit's scheduled expiration. Further, the outdated and complex formula for determining the regular R&E credit has become an increasingly inaccurate measure for determining a firm's incremental research expenditures.

To address these issues, the Administration proposes to make the research credit permanent and improve its incentive effect. A permanent research credit would improve the credit's incentive effect by providing businesses with certainty that they can make investments in long-term research projects and benefit from the credit over the course of the project. Increasing the rate of the alternative simplified credit from 14 percent to 17 percent will provide an improved incentive to increase research and, because the simplified credit base updates itself, the credit will more accurately reflect a firm's current operations.

The Administration's proposal for a permanent and enhanced R&E credit will provide an incentive for undertaking research activity in the United States by providing an estimated $106 billion in tax credits that will support nearly 1 million jobs in firms conducting the research.

Appendix: Additional Details on the Research and Experimentation Tax Credit – Defining Qualified Research

Qualified research expenses eligible for the research credit generally consist of: (1) in-house expenses of the taxpayer for wages and supplies attributable to qualified research; (2) certain time-sharing costs for computer use in qualified research; and (3) 65 percent of amounts paid or incurred by the taxpayer to certain other persons for qualified research conducted on the taxpayer's behalf ("contract research expenses"). Qualified research expenses include 100 percent of amounts paid or incurred by the taxpayer to an eligible small business, university, or Federal laboratory for qualified energy research.

To be eligible for the credit, the research must satisfy a number of requirements. The research must be undertaken for the purpose of discovering information that is technological in nature; the application of the research must be intended to be useful in the development of a new or improved business component of the taxpayer; and substantially all of the research activities must constitute elements of a process of experimentation for functional aspects, performance, reliability, or quality of a business component.

Research does not qualify for the credit if substantially all of the activities relate to style, taste, cosmetic, or seasonal design factors. In addition research does not qualify for the credit if (1) conducted after the beginning of commercial production of the business component; (2) related to the adaptation of an existing business component to a particular customer's requirements; (3) related to the duplication of an existing business component from a physical examination of the component itself or certain other information; or (4) related to certain efficiency surveys, management function or technique, market research, market testing, or market development, routine data collection or routine quality control. Research does not qualify for the credit if it is conducted outside the United States, Puerto Rico, or any U.S. possession.

To be eligible for the credit, research expenditures must be expenditures incurred in connection with the taxpayer's trade or business which represent research and development costs in the in the experimental or laboratory sense.

TAX INCENTIVES FOR RESEARCH, EXPERIMENTATION, AND INNOVATION

Scheduled for a Public Hearing
Before the
SENATE COMMITTEE ON FINANCE
on September 20, 2011

Prepared by the Staff
of the
JOINT COMMITTEE ON TAXATION

September 16, 2011
JCX-45-11

CONTENTS

INTRODUCTION

The Committee on Finance has scheduled a public hearing on September 20, 2011, concerning Federal tax incentives for research, experimentation, and innovation. This document,[1] prepared by the staff of the Joint Committee on Taxation, provides a summary and analysis of the present law Federal income tax rules designed to encourage these activities.

[1] This document may be cited as follows: Joint Committee on Taxation, *Tax Incentives for Research, Experimentation, and Innovation* (JCX-45-11), September 16, 2011. This document can be found on the website at www.jct.gov.

I. DESCRIPTION OF PRESENT LAW FEDERAL TAX INCENTIVES FOR RESEARCH

A. Deduction for Research Expenditures

Business expenses associated with the development or creation of an asset having a useful life extending beyond the current year must generally be capitalized and depreciated over such useful life. Taxpayers, however, may elect to deduct currently the amount of certain reasonable research or experimentation expenditures paid or incurred in connection with a trade or business.[2] Taxpayers may choose to forgo a current deduction, capitalize their research expenditures, and recover them ratably over the useful life of the research, but in no case over a period of less than 60 months.[3] Taxpayers, alternatively, may elect to amortize their research expenditures over a period of 10 years.[4] Generally, such deductions are reduced by the amount of the taxpayer's research tax credit (discussed in more detail in section B).[5]

Amounts defined as research and experimental expenditures under section 174 generally include all costs incurred in the experimental or laboratory sense related to development or improvement of a product.[6] In particular, qualifying costs are those incurred for activities intended to discover information that would eliminate uncertainty concerning the development or improvement of a product.[7] Uncertainty exists when information available to the taxpayer is not sufficient to ascertain the capability or method for developing, improving, and/or appropriately designing the product.[8] The determination of whether expenditures qualify as deductible

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[2] Sec. 174. Unless otherwise noted, all section references are to the Internal Revenue Code of 1986, as amended.

[3] Sec. 174(b). Taxpayers generating significant short-term losses often choose to defer the deduction for their research and experimentation expenditures under this section. Additionally, section 174 amounts are excluded from the definition of "start-up expenditures" under section 195 (section 195 generally provides that start-up expenditures either are not deductible or are amortizable over a period of not less than 180 days once an active trade or business begins). So as not to generate significant losses before beginning their trade or business, a taxpayer may choose to defer the deduction and amortize the section 174 costs beginning with the month in which the taxpayer first realizes benefits from the expenditures.

[4] Secs. 174(f)(2) and 59(e). This special 10-year election is available to mitigate the effect of the alternative minimum tax adjustment for research expenditures set forth in section 56(b)(2). Taxpayers with significant losses also may elect to amortize their otherwise deductible research and experimentation expenditures to reduce amounts that could be subject to expiration under the NOL carryforward regime.

[5] Sec. 280C(c). Taxpayers may alternatively elect to claim a reduced research tax credit amount under section 41 in lieu of reducing deductions otherwise allowed. Sec. 280C(c)(3).

[6] Treas. Reg. sec. 1.174-2(a)(1) and (2). Product is defined to include any pilot model, process, formula, invention, technique, patent, or similar property, and includes products to be used by the taxpayer in its trade or business as well as products to be held for sale, lease, or license.

[7] Treas. Reg. sec. 1.174-2(a)(1).

[8] Treas. Reg. sec. 1.174-2(a)(1).

research expenses depends on the nature of the activity to which the costs relate, not the nature of the product or improvement being developed or the level of technological advancement the product or improvement represents. Examples of qualifying costs include salaries for those engaged in research or experimentation efforts, amounts incurred to operate and maintain research facilities (e.g., utilities, depreciation, rent), and expenditures for materials and supplies used and consumed in the course of research or experimentation (including amounts incurred in conducting trials).[9]

However, generally no current deduction is allowable for expenditures for the acquisition or improvement of land or of depreciable or depletable property used in connection with any research or experimentation.[10] In addition, no current deduction is allowed for research expenses incurred for the purpose of ascertaining the existence, location, extent, or quality of any deposit of ore or other mineral, including oil and gas.[11]

B. Credit for Increasing Research Activities

1. In general

For general research expenditures, a taxpayer may claim a research credit equal to 20 percent of the amount by which the taxpayer's qualified research expenses for a taxable year exceed its base amount for that year.[12] Thus, the research credit is generally available with respect to incremental increases in qualified research. An alternative simplified research credit (with a 14 percent rate and a different base amount) may be claimed in lieu of the 20-percent credit.

A 20-percent research tax credit is also available with respect to the excess of (1) 100 percent of corporate cash expenses (including grants or contributions) paid for basic research conducted by universities (and certain nonprofit scientific research organizations) over (2) the sum of (a) the greater of two minimum basic research floors plus (b) an amount reflecting any decrease in nonresearch giving to universities by the corporation as compared to such giving during a fixed-base period, as adjusted for inflation. This separate credit computation is commonly referred to as the university basic research credit.[13]

Finally, a research credit is available for a taxpayer's expenditures on research undertaken by an energy research consortium. This separate credit computation is commonly

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[9] Treas. Reg. sec. 1.174-2(a)(1). The definition of research and experimental expenditures also includes the costs of obtaining a patent, such as attorneys' fees incurred in making and perfecting a patent.

[10] Sec. 174(c).

[11] Sec. 174(d).

[12] Sec. 41.

[13] Secs. 41(a)(2) and (e).

referred to as the energy research credit. Unlike the other research credits, the energy research credit applies to all qualified expenditures, not just those in excess of a base amount.[14]

The research credit, including the university basic research credit and the energy research credit, expires for amounts paid or incurred after December 31, 2011.[15]

2. Eligible expenses

Qualified research expenses eligible for the research tax credit consist of: (1) in-house expenses of the taxpayer for wages and supplies attributable to qualified research; (2) certain time-sharing costs for computer use in qualified research; and (3) 65 percent of amounts paid or incurred by the taxpayer to certain other persons for qualified research conducted on the taxpayer's behalf (so-called "contract research expenses").[16] Notwithstanding the limitation for contract research expenses, qualified research expenses include 100 percent of amounts paid or incurred by the taxpayer to an eligible small business, university, or Federal laboratory for qualified energy research.[17]

To be eligible for the credit, the research not only has to satisfy the requirements of present-law section 174 (described in section A) but also must be undertaken for the purpose of discovering information that is technological in nature, the application of which is intended to be useful in the development of a new or improved business component of the taxpayer, and substantially all of the activities of which constitute elements of a process of experimentation for functional aspects, performance, reliability, or quality of a business component. Research does not qualify for the credit if substantially all of the activities relate to style, taste, cosmetic, or seasonal design factors.[18] In addition, research does not qualify for the credit if: (1) conducted after the beginning of commercial production of the business component; (2) related to the adaptation of an existing business component to a particular customer's requirements; (3) related to the duplication of an existing business component from a physical examination of the component itself or certain other information; or (4) related to certain efficiency surveys, management function or technique, market research, market testing, or market development,

[14] Sec. 41(a)(3).

[15] Sec. 41(h).

[16] Under a special rule, 75 percent of amounts paid to a research consortium for qualified research are treated as qualified research expenses eligible for the research credit (rather than 65 percent under the general rule under section 41(b)(3) governing contract research expenses) if (1) such research consortium is a tax-exempt organization that is described in section 501(c)(3) (other than a private foundation) or section 501(c)(6) and is organized and operated primarily to conduct scientific research, and (2) such qualified research is conducted by the consortium on behalf of the taxpayer and one or more persons not related to the taxpayer. Sec. 41(b)(3)(C).

[17] Sec. 41(b)(3)(D).

[18] Sec. 41(d)(3).

routine data collection or routine quality control.[19] Research does not qualify for the credit if it is conducted outside the United States, Puerto Rico, or any U.S. possession.[20]

3. Computation of allowable credit

Except for energy research payments and certain university basic research payments made by corporations, the research tax credit applies only to the extent that the taxpayer's qualified research expenses for the current taxable year exceed its base amount. The base amount for the current year generally is computed by multiplying the taxpayer's fixed-base percentage by the average amount of the taxpayer's gross receipts for the four preceding years. If a taxpayer both incurred qualified research expenses and had gross receipts during each of at least three years from 1984 through 1988, then its fixed-base percentage is the ratio that its total qualified research expenses for the 1984-1988 period bears to its total gross receipts for that period (subject to a maximum fixed-base percentage of 16 percent). All other taxpayers (so-called "start-up firms") are assigned a fixed-base percentage of three percent.[21]

In computing the credit, a taxpayer's base amount cannot be less than 50 percent of its current-year qualified research expenses.

To prevent artificial increases in research expenditures by shifting expenditures among commonly controlled or otherwise related entities, a special aggregation rule provides that all members of the same controlled group of corporations are treated as a single taxpayer.[22] Under regulations prescribed by the Secretary, special rules apply for computing the credit when a major portion of a trade or business (or unit thereof) changes hands. Under these rules, qualified research expenses and gross receipts for periods prior to the change of ownership of a trade or business are treated as transferred with the trade or business that gave rise to those expenses and receipts for purposes of recomputing a taxpayer's fixed-base percentage.[23]

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[19] Sec. 41(d)(4).

[20] Sec. 41(d)(4)(F).

[21] The Small Business Job Protection Act of 1996 expanded the definition of start-up firms under section 41(c)(3)(B)(i) to include any firm if the first taxable year in which such firm had both gross receipts and qualified research expenses began after 1983. A special rule (enacted in 1993) is designed to gradually recompute a start-up firm's fixed-base percentage based on its actual research experience. Under this special rule, a start-up firm is assigned a fixed-base percentage of three percent for each of its first five taxable years after 1993 in which it incurs qualified research expenses. A start-up firm's fixed-base percentage for its sixth through tenth taxable years after 1993 in which it incurs qualified research expenses is a phased-in ratio based on the firm's actual research experience. For all subsequent taxable years, the taxpayer's fixed-base percentage is its actual ratio of qualified research expenses to gross receipts for any five years selected by the taxpayer from its fifth through tenth taxable years after 1993. Sec. 41(c)(3)(B).

[22] Sec. 41(f)(1).

[23] Sec. 41(f)(3).

4. Alternative simplified credit

The alternative simplified research credit is equal to 14 percent of qualified research expenses that exceed 50 percent of the average qualified research expenses for the three preceding taxable years. The rate is reduced to six percent if a taxpayer has no qualified research expenses in any one of the three preceding taxable years. An election to use the alternative simplified credit applies to all succeeding taxable years unless revoked with the consent of the Secretary of the Treasury.

5. Impact on section 174 costs

However, deductions allowed to a taxpayer under section 174 (or any other section where such amounts qualify for the research credit) are reduced by an amount equal to 100 percent of the taxpayer's research tax credit determined for the taxable year.[24] Alternatively, taxpayers may elect to claim a reduced research tax credit amount under section 41 in lieu of reducing deductions otherwise allowed.[25]

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[24] Sec. 280C(c).

[25] Sec. 280C(c)(3).

II. ANALYSIS OF DEDUCTION AND CREDIT FOR RESEARCH EXPENDITURES

A. Overview

Technological development is an important component of economic growth. However, although an individual business may find it profitable to undertake some research, it may not find it profitable to invest in research as much as it otherwise might because it is difficult to capture the full benefits from the research and prevent such benefits from being used by competitors. In general, businesses acting in their own self-interest will not necessarily invest in research to the extent that would be consistent with the best interests of the overall economy. The reason for this behavior is because costly scientific and technological advances made by one firm may be cheaply copied by its competitors. Research is one area where economists agree that government intervention in the marketplace may improve overall economic efficiency. However, increased tax benefits or more government spending for research may not always improve economic efficiency. It is possible to decrease economic efficiency by spending too much on research. Nonetheless, there is evidence that the current level of research undertaken in the United States, and worldwide, is lower than the efficient level.[26] Nevertheless, even if there were agreement that additional subsidies for research are warranted as a general matter, misallocation of research dollars across competing sectors of the economy could diminish economic efficiency. It is difficult to determine whether increasing the current levels of government subsidies for research activities while retaining the current allocation of such subsidies would increase or decrease overall economic efficiency.

If it is believed that too little research is being undertaken, a tax subsidy is one method of offsetting the private-market bias against research, so that the quantity of research projects undertaken approaches the optimal level. Policies employed by the Federal government to increase the aggregate level of research activities are direct spending and grants, favorable anti-trust rules, and patent protection, among others. The effect of tax policy on research activity is largely uncertain because there is relatively little consensus regarding the magnitude of the responsiveness of research to changes in taxes and other factors affecting its price. To the extent that research activities are responsive to the price of research activities, the research and experimentation tax credit should increase research activities beyond what they otherwise would be. However, the present-law research credit contains certain complexities and compliance costs that may obscure this effect.

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[26] See Zvi Griliches, "The Search for R&D Spillovers," *Scandinavian Journal of Economics*, vol. XCIV, (1992); M. Ishaq Nadiri, "Innovations and Technological Spillovers," National Bureau of Economic Research, Working Paper No. 4423 (1993); and Bronwyn Hall, "The Private and Social Returns to Research and Development," in Bruce Smith and Claude Barfield (eds.), *Technology, R&D and the Economy*, Washington, D.C.: Brookings Institution Press (1996), pp. 1-14. These papers suggest that the rate of return to privately funded research expenditures is high compared to that in physical capital and the social rate of return exceeds the private rate of return. Griliches concludes, "in spite of [many] difficulties, there has been a significant number of reasonably well-done studies all pointing in the same direction: R&D spillovers are present, their magnitude may be quite large, and social rates of return remain significantly above private rates." Griliches, p. S43. Charles I. Jones and John C. Williams, "Measuring the Social Return to R&D," *Quarterly Journal of Economics*, 113 (November 1998), also conclude that "advanced economies like the United States substantially under invest in R&D" p. 1120.

B. Scope of Research Activities in the United States and Abroad

In the United States, private for-profit enterprises and individuals, non-profit organizations, and the public sector undertake research activities. Total expenditures on research and development in the United States represent 2.8 percent of gross domestic product in 2009.[27] This rate of expenditure on research and development exceeds that of the European Union (1.9 percent) and the average of all countries that are members of the Organisation for Economic Co-operation and Development ("OECD") (2.3 percent), but is less than that of Japan (3.3 percent). In 2009, expenditures on research and development in the United States represented 41.24 percent of all expenditures on research and development undertaken by OECD countries; they were 35 percent greater than the total expenditures on research and development undertaken in the European Union, and were approximately 2.7 times such expenditures in Japan.[28]

Gross domestic expenditures on research and development in the United States grew from 2.7 percent of gross domestic product to 2.8 percent gross domestic product over the ten year period 1999-2009. This rate of growth exceeds that of the United Kingdom (0.0 percentage point increase), and Sweden (0.0 percentage point increase) over this same period, but is less than that of Germany (0.4 percentage point increase), Japan (0.3 percentage point increase), Israel (0.8 percentage point increase), and South Korea (1.19 percentage point increase).[29]

Business domestic expenditures on research and development in the United States were 2.0 percent of gross domestic product in 2009. This exceeds that of the United Kingdom (1.1 percent), France (1.4 percent) and Germany (1.9 percent), but is less than that of Israel (3.4 percent), Japan (3.5 percent), and South Korea (3.5 percent).[30]

A number of countries, including the United States, provide tax benefits to taxpayers who undertake research activities. The United States provides two types of benefits: tax credits for research activity and current expensing of research-related expenditures.[31] These two types of

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[27] OECD, *Science, Technology and Industry Scoreboard, 2011*. This data represents outlays by private persons and by governments.

[28] OECD, *Science, Technology and Industry Scoreboard, 2011*. While the OECD attempts to present this data on a standardized basis, the cross-country comparisons are not perfect. For example, the United States reporting for research spending generally does not include capital expenditure outlays devoted to research, while the reporting of some other countries does include capital expenditures.

[29] OECD, *Science, Technology and Industry Scoreboard, 2011*. The annual real rate of growth of gross domestic expenditures on research and development as a percentage of gross domestic product for the period 1999-2009 in the European Union and in all OECD countries was 0.18 percentage points and 0.17 percentage points, respectively. All reported growth rates are calculated in terms of U.S. dollars equivalents converted at purchasing power parity.

[30] OECD, *Science, Technology and Industry Scoreboard, 2011*. The annual real rate of growth of business expenditures on research and development as a percentage of gross domestic product for the period 1999-2009 in the European Union and in all OECD countries was 0.06 percentage points and 0.13 percentage points, respectively. All reported growth rates are calculated in terms of U.S. dollar equivalents converted at purchasing power parity.

[31] In the case of expensing, amounts are expended to create an asset with a future benefit. In most other instances this would result in the capitalization and recovery through amortization of such costs. The inherent issue

benefits each carry different incentives with potentially different effects on research activity. For example, incentive effects of incremental credits per dollar of revenue loss may be larger than the incentive effects in expensing policies which are not incremental. However, expensing of research costs may have lower administrative and compliance costs than incremental credits.

The OECD has attempted to quantify the relative value of such tax benefits in different countries by creating an index that measures the total value of tax benefits accorded research activities relative to a simple expensing of all qualifying research expenditures. Table 1, below, reports the value of this index for selected countries. A value of zero results if the only tax benefit a country offered to research activities was the expensing of all qualifying research expenditures. Negative values reflect tax benefits less generous than expensing. Positive values reflect tax benefits more generous than expensing. For example, in 2008, in the United States qualifying taxpayers could expense research expenditures and, in certain circumstances, claim the research and experimentation tax credit. The resulting index number for the United States is 0.066.[32]

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with expenses incurred in research and development is whether or not an asset of any value is being (or will be) created. At the time the amounts are expended, such a determination is often impossible. Further, research and development costs usually are incurred with the goal of creating a new or improved product, service, process or technique, but more often than not, the efforts do not result in success. As such, U.S. GAAP does not require the capitalization and amortization of R&D costs.

[32] OECD, *Science, Technology and Industry Scoreboard, 2009*. The index is calculated as one minus the so-called "B-index." The B-index is equal to the after-tax cost of an expenditure of one dollar on qualifying research, divided by one minus the taxpayer marginal tax rate. Alternatively, the B-index represents the present value of pre-tax income that is necessary to earn to finance the research activity and earn a positive after-tax profit. In practice, construction of the B-index and the index number reported in Table 1 requires a number of simplifying assumptions. As a consequence, the relative position of the tax benefits of various countries reported in the table is only suggestive.

Table 1.−Index Number of Tax Benefits for Research Activities in Selected Countries, 2008

Country	Index Number[1]
Germany	-0.020
United States	0.066
United Kingdom	0.105
Ireland	0.109
Japan	0.116
Italy	0.117
Canada	0.180
Spain	0.349
France	0.425

[1]Index number reported is only that for "large firms." Some countries (notably Canada and the United Kingdom) have additional tax benefits for research activities of "small" firms.
Source: OECD, OECD Science, Technology and Industry Scoreboard, 2009.

C. Scope of Tax Expenditures on Research Activities

The tax expenditure related to the research and experimentation tax credit was estimated to be $4.9 billion for fiscal year 2009. The related tax expenditure for expensing of research and development expenditures was estimated to be $3.1 billion for 2009, growing to $6.5 billion for 2013.[33] The expenditures for fiscal years 2010 to 2014 are $12.6 billion and $26.3 billion for credits and expensing, respectively.[34]

As noted above, the Federal Government also directly subsidizes research activities. Direct government outlays for research have substantially exceeded the annual estimated value of the tax expenditure provided by either the research and experimentation tax credit or the expensing of research and development expenditures. For example, in fiscal 2008, the National Science Foundation gross outlays for research and related activities were $4.6 billion, the Department of Defense's budget for research, development, test and evaluation was $84.7 billion, the Department of Energy's science gross outlays were $3.9 billion, and the Department

[33] Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2009-2013* (JCS-1-10), January 11, 2010, p. 29.

[34] Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2010-2014 (JCS-3-10)*, December 15, 2010, p.35.

of Health and Human Services' budget for the National Institutes of Health was $28.9 billion.[35] However, such direct government outlays are generally for directed research on projects selected by the government. The research credit provides a subsidy to any qualified project of an eligible taxpayer with no application to a grant-making agency required. Projects are chosen based on the taxpayer's assessment of future profit potential.

Tables 2 and 3 present data for 2008 on those corporations that claimed the research tax credit by industry and asset size, respectively. Over 21,000 corporations (including both C corporations and S corporations) claimed more than $8.7 billion of research tax credits in 2008.[36] Corporations whose primary activity is manufacturing account for somewhat less than one-half of all corporations claiming a research tax credit. These manufacturers claimed nearly 70 percent of all credits. Firms with assets of $50 million or more account for 18 percent of all corporations claiming a credit but represent more than 85 percent of the credits claimed. Nevertheless, as Table 3 documents, a large number of small firms are engaged in research and were able to claim the research tax credit. C corporations claimed $8.3 billion of these credits and, furthermore, nearly all of this $8.3 billion was the result of the firm's own research. Only $168 million in research credits flowed through to C corporations from ownership interests in partnerships and other pass-through entities.

By comparison, individuals claimed $463 million in research tax credits on their individual income tax returns in 2008. This $463 million includes credits that flowed through to individuals from pass-through entities such as partnerships and S corporations, as well those credits generated by sole proprietorships.

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[35] Office of Management and Budget, *Appendix*, *Budget of the United States Government, Fiscal Year 2010*, pp. 1141, 293, 295, 297, 413, and 469.

[36] The $8.7 billion figure reported for 2008 is not directly comparable with the Joint Committee on Taxation Staff's $4.9 billion tax expenditure estimate for 2008 (Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2008-2012* (JCS-2-08), October 31, 2008, p. 60). The tax expenditure estimate accounts for the present-law requirement that deductions for research expenditures be reduced by research credits claimed. Also, the $8.7 billion figure does not reflect the actual tax reduction achieved by taxpayers claiming research credits in 2008, as the actual tax reduction will depend upon whether the taxpayer had operating losses, was subject to the alternative minimum tax, and other aspects specific to each taxpayer's situation.

Table 2.–Percentage Distribution of Corporations Claiming Research Tax Credit and Percentage of Credit Claimed by Sector, 2008

Industry	Percent of Corporations Claiming Credit	Percent of Total R & E Credit
Manufacturing	45.2	68.8
Professional, Scientific, and Technical Services	26.1	9.9
Wholesale Trade	7.6	4.4
Information	6.0	11.1
Finance and Insurance	3.0	1.7
Holding Companies	2.8	0.8
Administrative and Support and Waste Management and Remediation Services	1.5	0.3
Retail Trade	1.3	1.0
Health Care and Social Services	1.3	0.5
Mining	1.1	0.4
Agriculture, Forestry, Fishing, and Hunting	0.9	0.1
Construction	0.7	0.2
Utilities	0.6	0.6
Arts, Entertainment, and Recreation	0.6	(1)
Real Estate and Rental and Leasing	0.5	0.1
Transportation and Warehousing	0.3	0.1
Educational Services	0.3	(1)
Accommodation and Food Services	0.1	(1)
Other Services	(1)	(1)
Wholesale and Retail Trade not Allocable	(2)	(2)
Not Allocable	(2)	(2)

(1) Less than 0.1 percent.
(2) Data undisclosed to protect taxpayer confidentiality.
Source: Joint Committee on Taxation staff calculations from Internal Revenue Service, Statistics of Income data.

Table 3.–Percentage Distribution of Corporations Claiming Research Tax Credit and of Credit Claimed by Corporation Size, 2008

Asset Size ($)	Percent of Firms Claiming Credit	Percent of Credit Claimed
0	1.6	1.1
1 to 99,999	5.5	0.1
100,000 to 249,999	5.3	0.2
250,000 to 499,999	3.0	0.1
500,000 to 999,999	7.0	0.3
1,000,000 to 9,999,999	39.4	5.2
10,000,000 to 49,999,999	20.1	6.2
50,000,000 +	18.0	86.9

Totals may not add to 100 percent due to rounding.
Source: Joint Committee on Taxation staff calculations from Internal Revenue Service, Statistics of Income data.

D. Flat Versus Incremental Tax Credits

For a tax credit to be effective in increasing a taxpayer's research expenditures, it is not necessary to provide that credit for all the taxpayer's research expenditures (i.e., a flat credit). By limiting the credit to expenditures above a base amount, incremental tax credits attempt to target the tax incentives to have the largest effect on taxpayer behavior.

Suppose, for example, a taxpayer is considering two potential research projects: Project A will generate cash flow with a present value of $105 and Project B will generate cash flow with a present value of $95. Suppose that the research cost of investing in each of these projects is $100. Without any tax incentives, the taxpayer will find it profitable to invest in Project A and will not invest in Project B.

Alternatively, consider the situation where a 10-percent flat credit applies to all research expenditures incurred. In the case of Project A, the credit effectively reduces the cost to $90. This increases profitability, but does not change behavior with respect to that project, since it would have been undertaken in any event. However, because the cost of Project B also is reduced to $90, this previously neglected project (with a present value of $95) would now be profitable. Thus, the tax credit would affect behavior only with respect to this marginal project.

Incremental credits do not attempt to reward projects that would have been undertaken in any event, but rather to target incentives to marginal projects. To the extent this is possible, incremental credits have the potential to be far more effective per dollar of revenue cost than flat credits in inducing taxpayers to increase qualified expenditures. In the example above, if an incremental credit were properly targeted, the government could spend the same $20 in credit dollars and induce the taxpayer to undertake a marginal project so long as its expected cash flow exceeded $80. Unfortunately, it is nearly impossible as a practical matter to determine which projects would be undertaken in the absence of a credit and to provide credits only to those projects which would not have been undertaken. In practice, almost all incremental credit proposals rely on some measure of the taxpayer's previous experience as a proxy for a taxpayer's total qualified expenditures in the absence of a credit. This amount is referred to as the credit's base amount. Tax credits are provided only for amounts above this base amount.

Because a taxpayer's calculated base amount is only an approximation of what would have been spent in the absence of a credit, in practice, the credit may be less than optimally effective per dollar of revenue cost. If the calculated base amount is too low, the credit is awarded to projects that would have been undertaken even in the absence of a credit. If, on the other hand, the calculated base amount is too high, then there is no incentive for projects that are on the margin.

Nevertheless, the incentive effects of incremental credits per dollar of revenue loss can be many times larger than those of a flat credit. However, a flat credit generally has lower administrative and compliance costs than an incremental credit. Another important consideration is the potentially less than optimal allocation of resources and unfair competition that could result as firms with qualified expenditures determined to be above their base amount receive credit dollars, while other firms with qualified expenditures determined to be below their base amount receive no credit.

E. Fixed Base Versus Moving Base Credit

Taxpayers effectively have the choice of two different research credit structures for general research expenditures: the regular credit and the alternative simplified credit.[37] The regular credit is a wholly "incremental" credit, while the alternative simplified credit has an incremental feature. In addition, the base is determined differently in each case. The regular credit is a "fixed base" credit. With a fixed base credit, the incremental amount of qualified research expenditures is determined with reference to prior qualified research expenditures incurred over a fixed period of time. The alternative simplified credit is a "moving base" credit. With a moving base credit, the incremental amount of qualified research expenditures for a given year is determined by reference to qualified research expenditures incurred on a rolling basis in one or more prior years. The distinction can be important because, in general, an incremental tax credit with a base amount equal to a moving average of previous years' qualified expenditures is considered to have an effective rate of credit substantially below its statutory rate. On the other hand, an incremental tax credit with a base amount determined as a fixed base generally is considered to have an effective rate of credit equal to its statutory rate.

To understand how a moving base creates a reduction in the effective rate of credit, consider the structure of the alternative simplified credit. The base of the credit is equal to 50 percent of the previous three years' average of qualified research expenditures. Assume a

[37] A taxpayer election into one of these structures is permanent unless revoked by the Secretary. However, historically, permission to revoke an election has routinely been granted by the Secretary, effectively making the choice an annual election.

taxpayer has been claiming the alternative simplified credit and is considering increasing his qualified research expenditures this year. A $1 increase in qualified expenditures in the current year will earn the taxpayer 14 cents in credit in the current year but it will also increase the taxpayer's base amount by 16.7 cents (50 percent of $1 divided by three) in each of the next three years. If the taxpayer returns to his previous level of research funding over the subsequent three years, the taxpayer will receive two and one-third cents less in credit than he otherwise would have. Assuming a nominal discount rate of 10 percent, the present value of the one year of credit increased by 14 cents followed by three years of credits reduced by two and one-third cents is equal to 8.19 cents. That is, the effective credit rate on a $1 dollar increase in qualified expenditures is 8.19 percent.

An additional feature of the moving average base calculation of the alternative simplified credit is that it is not always an incremental credit. If the taxpayer never alters his research expenditures, the alternative simplified credit is the equivalent of a flat rate credit with an effective credit value equal to one half of the statutory credit rate. Assume a taxpayer spends $100 per year annually on qualified research expenses. This taxpayer will have an annual base amount of $50, with the result that the taxpayer will have $50 of credit eligible expenditures on which the taxpayer may claim $7 of tax credit (14 percent of $50). For this taxpayer, the 14-percent credit above the defined moving average base amount is equivalent to a seven-percent credit on the taxpayer's $100 of annual qualifying research expenditures.

The moving average base calculation of the alternative simplified credit also can permit taxpayers to claim a research credit while they decrease their research expenditures. Assume as before that the taxpayer has spent $100 annually on qualified research expenses, but decides to reduce research expenses in the next year to $75 and in the subsequent year to $50, after which the taxpayer plans to maintain research expenditures at $50 per year. In the year of the first reduction, the taxpayer would have $25 of qualifying expenditures (the taxpayer's prior three-year average base is $100) and could claim a credit of $3.50 (14 percent of the $75 current year expenditure less half of three year average base). In the subsequent four years, the taxpayer could claim a credit of $0.58, $1.75, $2.92, and $3.50.[38] Of course, it is also the case that a taxpayer may claim a research credit as he reduces research expenditures under a fixed base credit as long as the taxpayer's level of qualifying expenditures is greater than the fixed base.

Some have also observed that a moving base credit can create incentives for taxpayers to "cycle" or bunch their qualified research expenditures. For example, assume a taxpayer who is claiming the alternative simplified credit has had qualified research expenditures of $100 per year for the past three years and is planning on maintaining qualified research expenditures at $100 per year for the next three years. The taxpayer's base would be $50 for each of the next three years and the taxpayer could claim $7 of credit per year. If, however, the taxpayer could bunch expenditures so that the taxpayer incurred only $50 of qualified research next year, followed by $150 in the second year and $100 in the third, the taxpayer could claim no credit next year but $15.17 in the second year and $7 dollars in the third. While the example

[38] In the subsequent four years, 50 percent of the prior three years' expenditures equals $45.83, $37.50, $29.17, and $25.00. In each year, the taxpayer's expenditure of $50 exceeds 50 percent of the prior three years' expenditures.

demonstrates a benefit to cycling, as the majority of qualified research expenditures consist of salaries to scientists, engineers, and other skilled labor, the potential for cycling would likely be limited in practice.

F. The Responsiveness of Research Expenditures to Tax Incentives

As with any other commodity, economists expect the amount of research expenditures a firm incurs to respond positively to a reduction in the price paid by the firm. Economists often refer to this responsiveness in terms of price elasticity, which is measured as the ratio of the percentage change in quantity to a percentage change in price. For example, if demand for a product increases by five percent as a result of a 10-percent decline in price paid by the purchaser, that commodity is said to have a price elasticity of demand of 0.5.[39] One way of reducing the price paid by a buyer for a commodity is to grant a tax credit upon purchase. A tax credit of 10 percent (if it is refundable or immediately usable by the taxpayer against current tax liability) is equivalent to a 10-percent price reduction. If the commodity granted a 10-percent tax credit has an elasticity of 0.5, the amount consumed will increase by five percent. Thus, if a flat research tax credit were provided at a 10-percent rate, and research expenditures had a price elasticity of 0.5, the credit would increase aggregate research spending by five percent.[40]

While most, if not all, published studies report that the research credit induces increases in research spending, the evidence generally indicates that the price elasticity for research is substantially less than one. For example, one survey of the literature reaches the following conclusion:

> "In summary, most of the models have estimated long-run price elasticities of demand for research and development on the order of -0.2 and -0.5. However, all of the measurements are prone to aggregation problems and measurement errors in explanatory variables."[41]

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[39] For simplicity, this analysis assumes that the product in question can be supplied at the same cost despite any increase in demand (i.e., the supply is perfectly elastic). This assumption may not be valid, particularly over short periods of time, and particularly when the commodity–such as research scientists and engineers–is in short supply.

[40] It is important to note that not all research expenditures need be subject to a price reduction to have this effect. Only the expenditures that would not have been undertaken otherwise–so called marginal research expenditures–need be subject to the credit to have a positive incentive effect.

[41] Charles River Associates, "An Assessment of Options for Restructuring the R&D Tax Credit to Reduce Dilution of its Marginal Incentive" (final report prepared for the National Science Foundation) (February 1985), p. G-14. The negative coefficient in the text reflects that a decrease in price results in an increase in research expenditures. Often, such elasticities are reported without the negative coefficient, it being understood that there is an inverse relationship between changes in the "price" of research and changes in research expenditures.

In a 1983 study, the Treasury Department used an elasticity of 0.92 as its upper range estimate of the price elasticity of R&D, but noted that the author of the unpublished study from which this estimate was taken conceded that the estimate might be biased upward. See Department of the Treasury, "The Impact of Section 861-8 Regulation on Research and Development," p. 23. As stated in the text, although there is uncertainty, most analysts believe the elasticity is considerably smaller. For example, the General Accounting Office (now called the

If it took time for taxpayers to learn about the credit and what sort of expenditures qualified, taxpayers may have only gradually adjusted their behavior. Such a learning curve might explain a modest measured behavioral effect. A more recent survey of the literature on the effect of the tax credit suggests a stronger behavioral response, although most analysts agree that there is substantial uncertainty in these estimates.

> "[W]ork using US firm-level data all reaches the same conclusion: the tax price elasticity of total research and development spending during the 1980s is on the order of unity, maybe higher. … Thus there is little doubt about the story that the firm-level publicly reported research and development data tell: the research tax credit produces roughly a dollar-for-dollar increase in reported research and development spending on the margin."[42]

However, this survey notes that most of this evidence is not drawn directly from tax data. For example, effective marginal tax credit rates are inferred from publicly reported financial data

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Government Accountability Office) summarizes: "These studies, the best available evidence, indicate that spending on R&E is not very responsive to price reductions. Most of the elasticity estimates fall in the range of 0.2 and 0.5. . . Since it is commonly recognized that all of the estimates are subject to error, we used a range of elasticity estimates to compute a range of estimates of the credit's impact." See *The Research Tax Credit Has Stimulated Some Additional Research Spending* (GAO/GGD-89-114) (September 1989), p. 23. Similarly, Edwin Mansfield concludes: "While our knowledge of the price elasticity of demand for R&D is far from adequate, the best available estimates suggest that it is rather low, perhaps about 0.3," in Edwin Mansfield, "The R&D Tax Credit and Other Technology Policy Issues," *American Economic Review*, vol. 76, no. 2 (May 1986), p. 191.

[42] Bronwyn Hall and John Van Reenen, "How Effective Are Fiscal Incentives for R&D? A Review of the Evidence," *Research Policy*, vol. 29, 2000, p. 462. This survey reports that more recent empirical analyses have estimated higher elasticity estimates. One recent empirical analysis of the research credit has estimated a short-run price elasticity of 0.8 and a long-run price elasticity of 2.0. The author of this study notes that the long-run estimate should be viewed with caution for several technical reasons. In addition, the data utilized for the study cover the period 1980 through 1991, containing only two years under the revised credit structure. This makes it empirically difficult to distinguish short-run and long-run effects, particularly as it may take firms some time to appreciate fully the incentive structure of the revised credit. See Bronwyn H. Hall, "R&D Tax Policy During the 1980s: Success or Failure?" in James M. Poterba (ed.), *Tax Policy and the Economy*, vol. 7 Cambridge: The MIT Press (1993), pp. 1-35. Another recent study examined the post-1986 growth of research expenditures by 40 U.S.-based multinationals and found price elasticities between 1.2 and 1.8. However, the estimated elasticities fell by half after including an additional 76 firms that had initially been excluded because they had been involved in merger activity. See James R. Hines, Jr., "On the Sensitivity of R&D to Delicate Tax Changes: The Behavior of U.S. Multinationals in the 1980s" in Alberto Giovannini, R. Glenn Hubbard, and Joel Slemrod (eds.), *Studies in International Taxation*, Chicago: University of Chicago Press (1993). Also see M. Ishaq Nadiri and Theofanis P. Mamuneas, "R&D Tax Incentives and Manufacturing-Sector R&D Expenditures," in James M. Poterba, (ed.), *Borderline Case: International Tax Policy, Corporate Research and Development, and Investment,* Washington, D.C.: National Academy Press (1997). While their study concludes that one dollar of research tax credit produces 95 cents of research, they note that time series empirical work is clouded by poor measures of the price deflators used to convert nominal research expenditures to real expenditures.

Other research suggests that many of the elasticity studies may overstate the efficiency of subsidies to research. Most R&D spending is for wages and the supply of qualified scientists is small, particularly in the short run. Subsidies may raise the wages of scientists, and hence research spending, without increasing actual research. See Austan Goolsbee, "Does Government R&D Policy Mainly Benefit Scientists and Engineers?," *American Economic Review*, vol. 88 (May 1998), pp. 298-302.

and may not reflect limitations imposed by operating losses or the AMT. The study notes that because most studies rely on "reported research expenditures," a "relabeling problem" may exist whereby preferential tax treatment for an activity gives firms an incentive to reclassify expenditures as qualifying expenditures. If this occurs, reported expenditures increase in response to the tax incentive by more than the underlying real economic activity. Thus, reported estimates may overestimate the true response of research spending to the tax credit.[43]

To our knowledge, there have been no specific studies of the effectiveness of the university basic research tax credit.

G. Other Policy Issues Related to the Research and Experimentation Credit

Design features

Perhaps the greatest taxpayer criticism of the research and experimentation tax credit concerns its temporary nature. Research projects frequently span years. If a taxpayer considers an incremental research project, the lack of certainty regarding the availability of future credits increases the financial risk of the expenditure. A credit of longer duration may more successfully induce additional research than would a temporary credit, even if the temporary credit is periodically renewed.

An incremental credit does not provide an incentive for all firms undertaking qualified research expenditures. If the credit is wholly incremental, many firms will have current-year qualified expenditures below the base amount. These firms will receive no tax credit and will have an effective credit rate of zero. Although there is no revenue cost associated with firms with qualified expenditures below the base amount, there may be a distortion in the allocation of resources as a result of these uneven incentives. The alternative simplified credit, with its "moving base" structure and limited incremental feature, partially avoids this problem.

If a firm has no current tax liability, or if the firm is subject to the AMT or the general business credit limitation, the research credit must be carried forward for use against future-year tax liabilities. The inability to use a tax credit immediately reduces its present value according to the length of time between when it is earned and the time it actually is used to reduce tax liability.[44]

Effective rate of credit

Except for energy research, firms with research expenditures substantially in excess of their base amount are subject to the 50-percent base amount limitation. In general, although these firms received the largest amount of credit when measured as a percentage of their total

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[43] Hall and Van Reenen, "How Effective Are Fiscal Incentives for R&D? A Review of the Evidence," p. 463.

[44] As with any tax credit that is carried forward, its full incentive effect could be restored, absent other limitations, by allowing the credit to accumulate interest that is paid by the Treasury to the taxpayer when the credit ultimately is utilized.

qualified research expenses, their marginal effective rate of credit was exactly one half of the statutory credit rate of 20 percent (i.e., firms subject to the base limitation are effectively governed by a 10-percent credit rate).

Although the statutory rate of the research credit is 20 percent, it is likely that the average effective marginal rate may be substantially below 20 percent. Reasonable assumptions about the frequency with which firms are subject to various limitations discussed above yield estimates of an average effective rate of credit between 25 and 40 percent below the statutory rate, i.e., between 12 and 15 percent.[45]

Since sales growth over a long time frame will rarely track research growth, it can be expected that over time each firm's base will drift from the firm's actual current qualified research expenditures. Therefore, if the research credit were made permanent, increasingly over time there would be a larger number of firms either substantially above or below their calculated base. This could gradually create an undesirable situation where many firms would receive no credit and have no reasonable prospect of ever receiving a credit, while other firms would receive large credits (despite the 50-percent base amount limitation). Thus, over time, it can be expected that, for those firms eligible for the credit, the average effective marginal rate of credit would decline while the revenue cost to the Federal government increased. The alternative simplified credit structure avoids this problem by having a moving base.

Sector-specific subsidies

As explained above, because costly scientific and technological advances made by one firm may often be cheaply copied by its competitors, research is one area where economists agree that government intervention in the marketplace, such as the subsidy of the research tax credit, can improve overall economic efficiency. This rationale suggests that the problem of a socially inadequate amount of research is not more likely in some industries than in other industries, but rather it is an economy-wide problem. The basic economic rationale argues that a subsidy to reduce the cost of research should be equally applied across all sectors. As described above, the Energy Policy Act of 2005 provided that energy- related research receive a greater tax subsidy than other research. Some argue that it makes the tax subsidy to research inefficient by biasing the choice of research projects. They argue that an energy-related research project could be funded by the taxpayer in lieu of some other project that would offer a higher rate of return absent the more favorable tax credit for the energy-related project. Proponents of the differential treatment for energy-related research argue that broader policy concerns such as promoting energy independence justify creating a bias in favor of energy related research.

Definitional issues

A 2009 Government Accountability Office ("GAO") study highlights several definitional issues affecting the administrability of the research credit, including the definition of credit-

[45] For a more complete discussion of this point, see Joint Committee on Taxation, *Description and Analysis of Tax Provisions Expiring in 1992* (JCS-2-92), January 27, 1992, pp. 65-66.

eligible supplies and internal use software.[46] In 1986, Congress narrowed the definition of credit-eligible research to exclude most research expenditures for the development of computer software for the taxpayer's own internal use. Specifically, research with respect to computer software that is developed by or for the benefit of the taxpayer primarily for the taxpayer's own internal use is eligible for the research credit only if the software is used in (1) qualified research (other than the development of the internal-use software itself) undertaken by the taxpayer, or (2) a production process that meets the requirements for the credit. Any other research activities with respect to internal-use software are not eligible for the credit except to the extent provided in regulations. Congress intended that regulations would make the costs of new or improved internal-use software credit eligible only if, in addition to satisfying all other requirements for the credit, the taxpayer establishes that (1) the software is innovative (e.g., the software results in a reduction in costs, or improvement in speed, that is substantial and economically significant), (2) the software development involves significant economic risk (e.g., the taxpayer commits substantial resources to the development and there is substantial uncertainty because of technical risk that such resources would be recovered with a reasonable period), and (3) the software is not commercially available for use by the taxpayer (e.g., the software cannot be purchased, leased, or licensed and used for the intended purpose).

In the conference report to the Tax Relief Extension Act of 1999, Congress noted "the rapid pace of technological advance, especially in service-related industries," and suggested that software research that otherwise satisfies the requirements of section 41 that is undertaken to support the provision of a service, should not be deemed "internal use" solely because the business component involves the provision of a service.[47]

Treasury's most recent attempt at guidance with respect to internal-use software was in a 2004 Advance Notice of Proposed Rulemaking in which Treasury noted that "the Treasury Department and the IRS are concerned about the difficulty of effecting Congressional intent behind the exclusion for internal-use software with respect to computer software being developed today. Despite Congress's broad grant of regulatory authority in section 41(d)(4)(E), the Treasury Department and the IRS believe that this authority may not be broad enough to resolve those difficulties."[48]

The uncertainty as to the availability of the research credit for the development of internal-use software may shift investment away from such research to other research which is clearly eligible for the credit. Such a shift may not represent the most efficient allocation of research funding.

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[46] Government Accountability Office, *The Research Tax Credit's Design and Administration Can Be Improved* (GAO-10-136), November 2009, pp. 69-79. Other issues included the definition of commercial production and the general qualification tests.

[47] H.R. Conf. Rep. No. 106-478, p. 132 (1999).

[48] 69 Fed. Reg. 43, 46 (January 2, 2004).

A second definitional issue relates to credit-eligible supplies expenditures. A 2009 court case concluded that supplies expenditures incurred with respect to property held for sale by the taxpayer were credit eligible even though identical costs with respect to property used in the taxpayer's trade or business were ineligible.[49] Present law generally treats as credit-eligible supplies expenditures for tangible property other than land, improvements to land, or property of a character subject to an allowance for depreciation. Taxpayers and the IRS disagree as to whether the cost of supplies used in constructing tangible property such as molds and prototypes, where such items are held for sale by the taxpayer, are eligible for the research credit.[50]

While allowing credits for a relatively expansive definition of research supplies might increase total credits claimed substantially, this does not by itself make the credit more or less efficient. What determines the efficiency of research subsidies is, as discussed above, the extent to which such subsidies cause new research that generates benefits for firms or individuals other than the researching firm.

Thus, if defining "supplies" more expansively causes additional research that other firms may copy easily, then the resulting increase in tax expenditures may improve economic efficiency if the benefit derived by other firms is sufficiently high. On the other hand, opponents may believe that relative to other credit-eligible expenditures, supplies expenditures are either less likely to benefit other firms, or that any such external benefits are particularly mild, or perhaps less likely to induce more research. Alternately, they might argue that, in principle, supplies expenditures improve efficiency, but that "supplies" is improperly defined so as to allow the inclusion of too many tangible goods with benefits accruing solely to the researching firm. If so, it might be argued that modifying the credit to limit the definition of supplies (or possibly disallowing the credit for supplies expenditures entirely) and focusing the credit on other forms of research or other expenditures could improve economic efficiency and any social benefits of research without requiring an increase in tax expenditures.

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[49] *T.G. Missouri Corp. v. Commissioner*, 133 T.C. 278 (2009). This case involved a taxpayer who developed and used production molds to manufacture auto parts. The taxpayer paid third-party toolmakers to build the production molds and then incurred additional design and engineering costs to modify the molds so that they could be used to produce the desired component parts. Some of the molds were then sold to the taxpayer's customers while others were not. In both cases, the taxpayer retained physical possession of the molds and used them to produce the parts. The findings of the Tax Court were that the molds sold to the taxpayer's customers were not depreciable assets (as required by section 41(b)(2)(C)(ii)) because they were held for resale. Thus, the costs associated with the molds were properly includable as supply costs for purposes of calculating the research credit (whereas costs associated with the molds that were not sold received the opposite result). See also *Trinity Industries v. United States*, 691 F. Supp. 2d 688 (DC TX 2010).

[50] Under present law, taxpayers also may be able to claim the research credit for what might otherwise be relatively routine supply costs. For example, consider a hypothetical cattle-raising firm trying to determine whether a new genetically-modified feed improves the size and health of its cows. One straightforward way of testing the new feed would be to give the new feed to a random sample of the firm's existing cattle and compare the results relative to the rest of the herd. In principle, such a firm might be able to claim a credit for all of the feed, including the regular feed given to the "control group" (i.e., all of the rest of the cows), even though the firm obviously would have fed all of the animals whether conducting this experiment or not.

Administrative complexity

Administrative and compliance burdens result from the research tax credit. The GAO has testified that the research tax credit is difficult for the IRS to administer.[51] According to the GAO, the IRS reports that it is required to make difficult technical judgments in audits concerning whether research is directed to produce truly innovative products or processes. Although the IRS employs engineers in such audits, the companies engaged in the research typically employ personnel with greater technical expertise and, as would be expected, personnel with greater expertise regarding the intended application of the specific research conducted by the company under audit. Such audits create a burden for both the IRS and taxpayers. The credit generally requires taxpayers to maintain records more detailed than those necessary to support the deduction of research expenses under section 174.[52] An executive in a large technology company has identified the research credit as one of the most significant areas of complexity for his firm. He summarizes the problem as follows:

> "Tax incentives such as the R&D tax credit … typically pose compliance challenges, because they incorporate tax-only concepts that may be only tenuously linked to financial accounting principles or to the classifications used by the company's operational units. … [I]s what the company calls "research and development" the same as the "qualified research" eligible for the R&D tax credit under I.R.C. Section 41? The extent of any deviation in those terms is in large part the measure of the compliance costs associated with the tax credit."[53]

In addition to compliance challenges, with the addition of the alternative simplified credit, taxpayers now have multiple research credit structures to choose from, including the energy research credit and the university basic research credit. The presence of multiple research credit options creates increased complexity by requiring taxpayers to make multiple calculations to determine which credit structure will result in the most favorable tax treatment.

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[51] Natwar M. Gandhi, Associate Director Tax Policy and Administration Issues, General Government Division, U.S. General Accounting Office, "Testimony before the Subcommittee on Oversight: Additional Information on the Research Credit," Committee on Ways & Means, United States House of Representatives, May 10, 1995. See also, Government Accountability Office, *The Research Tax Credit's Design and Administration Can Be Improved*, November 2009, pp. 87-98, noting that common controversy issues include the use of a cost center versus project accounting approach to tracking research expenditures, sufficiency of base period documentation, and sampling issues.

[52] Natwar M. Gandhi, Associate Director Tax Policy and Administration Issues, General Government Division, U.S. General Accounting Office, "Testimony before the Subcommittee on Taxation and Internal Revenue Service Oversight: Information on the Research Credit," Committee on Finance, United States Senate, April 3, 1995.

[53] David R. Seltzer, "Federal Income Tax Compliance Costs: A Case Study of Hewlett-Packard Company," *National Tax Journal*, vol. 50 (September 1997), pp. 487-493.

HM Revenue & Customs

The Patent Box: Technical Note

and Guide to the Draft Legislation

Technical Note
6/12/2011

Contents | Page

Foreword:

This Technical Note accompanies draft clauses and explanatory notes published today, 6 December 2011. It should also be read alongside the response document to the June 2011 consultation on the Patent Box which has also been published today.

This note gives an outline of the structure of the legislation intended to deliver the policy set out in the response document. It aims to provide a guide to the draft legislation and where appropriate to explain the reasons for approaching the policy objectives in the way the legislation does.

The response document invites comments on how well the legislation succeeds in achieving the policy objectives. Comments on the legislation or this note specifically are very welcome and should be sent by email to:

corporatetaxreform@hmtreasury.gsi.gov.uk

And to **richard.rogers@hmrc.gsi.gov.uk**

Or, if you wish to respond by mail, please send responses to

CT Reform
Corporate Tax Team
HM Treasury
1 Horse Guards Parade
London
SW1A 2HQ

Chapter 1 – Introduction & Overview

Purpose of the Patent Box

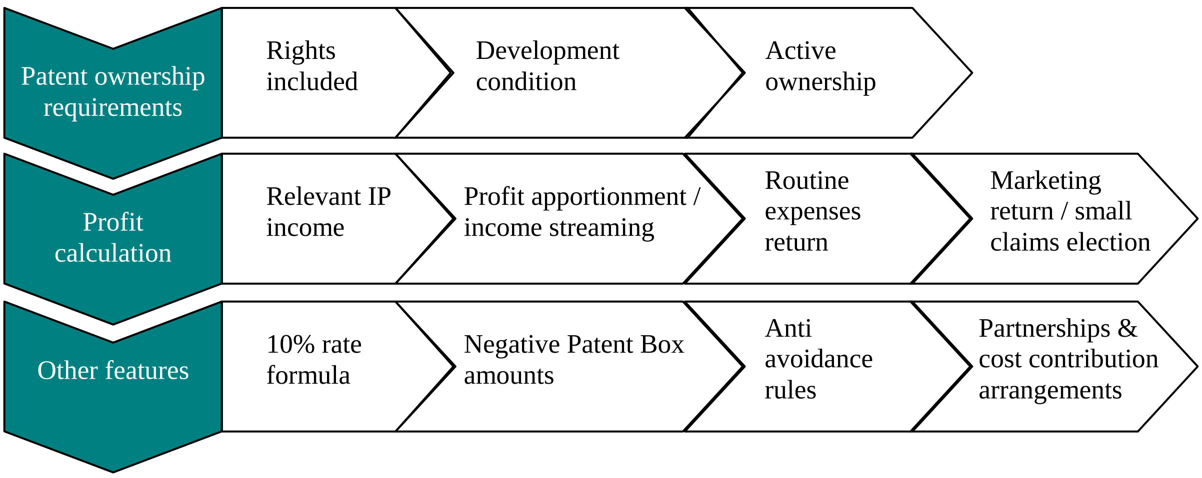
1.1. The Patent Box provides a reduced corporation tax rate for companies exploiting patented inventions or certain other innovations protected by particular intellectual property (IP) rights.

1.2. The reduced rate applies to a proportion of the profits derived from the licensing or sale of the patent rights, or from the sale of the patented invention or products which incorporate the patented invention. Profits derived from routine manufacturing or development functions, and profits derived from exploitation of brand and marketing intangible assets, are intended to be excluded.

1.3. The Patent Box is an optional regime which companies can elect into. The reduced rate of tax is delivered by providing an additional deduction in the corporation tax computation.

1.4. To minimise administrative costs and compliance burden, Patent Box profits for many claims can be calculated using a largely formulaic approach. This is intended to identify in most circumstances a reasonable, albeit approximate, figure for profit derived from the patent. Companies can instead however opt to identify the profit through a more bespoke calculation.

1.5. The next section of this introduction is a broad outline of the main concepts of the Patent Box regime. These are then explained in more detail in the rest of this Technical Note, The main concepts are shown in the diagram below:



An Overview of the Patent Box

(i) Qualifying Ownership Requirements

1.6. A company can elect into the Patent Box if it owns or licenses-in UK or European Patent Office patents. There are two main conditions:

(i) the company must have made undertaken qualifying development by making a significant contribution to:

- the creation or development of the item protected by the patent; or
- a product incorporating this item.

(ii) if the company licenses-in patent rights, the licence must give it exclusivity for those rights. This must extend at least country-wide.

1.7. Some other rights, such as plant variety and data exclusivity rights, can also qualify. These rights are treated in the same way as patents throughout the legislation, so unless specified otherwise references to "patented item" in this note should be read as also referring to items or products protected by any other type of qualifying IP right.

1.8. If the company is a member of a group, then in some circumstances it can qualify if another group company has undertaken the qualifying development. But only if it actively manages its portfolio of qualifying rights.

1.9. This requires a significant amount of management activity: forming plans and making decisions about the portfolio. However the company does not have to make all decisions concerning the portfolio.

(ii) Profits Benefitting from the Patent Box

1.10. The profits benefiting from the Patent Box are calculated as a proportion of the corporation tax profit of the company's trade.

Relevant IP income

1.11. The calculation starts by identifying how much of the company's total gross income includes "relevant IP income" (RIPI), which is income derived from its qualifying patents.

1.12. Broadly there are five types of income that can qualify as relevant IP income:

i. income from the sale of the patented item, or an item incorporating it;

ii. licence fees and royalties from rights that the company grants others out of its own rights over the patented item;

iii. income from the sale or disposal of the patent;

iv. amounts received from others accused of infringing the patent; and

v. a notional arms-length royalty for use of the patent to generate otherwise non-qualifying parts of the company's total gross income, if they are derived from exploiting the patented item.

1.13. For these purposes, finance income is not part of the company's gross income. Additionally, neither ring-fence oil extraction income nor income from exploiting non-exclusive patent rights can qualify.

Profit Apportionment/ Income Streaming

1.14. The company can normally choose one of two routes to calculate how much of its profits derive from this qualifying income. Either:

(i) it can apportion its total profits according to the ratio of RIPI to total gross income; or

(ii) it can allocate its expenses on a just and reasonable basis to the two "streams" of income: RIPI and non-qualifying income, to arrive at an appropriate profit derived from its RIPI stream.

1.15. Profits apportioned or expenses attributed should exclude finance income and expenses. They should also exclude any additional deduction above actual cost for research and development costs given under the R&D tax credits regime.

Removing a Routine Return

1.16. Two further stages are necessary in the calculation. The first is to remove a routine return on certain specified costs from the apportioned or streamed patent-derived profits. This leaves an amount called "Qualifying Residual Profit" (QRP).

1.17. The relevant costs include costs of personnel, premises (if tax-deductible), plant and machinery (including capital allowances) and miscellaneous services. Expenditure qualifying for R&D tax credits is excluded.

1.18. The return is set at 10% of these costs, and the profit is reduced by this amount.

Removing a Marketing Assets Return

1.19. The final stage is either:

- to remove a return on marketing assets used to derive profits, by deducting a notional marketing royalty; or
- to apply small claims treatment to the QRP, which removes 25% of QRP as a deemed marketing return, leaving the remaining 75% (up to a maximum of £1m) inside the Patent Box.

1.20. In either case the result is a profit figure called Relevant IP Profits (RIPP) which can then benefit from the Patent Box

(iii) Applying the Patent Box to Relevant IP Profits (RIPP)

1.21. The Patent Box taxes RIPP at a reduced rate. This is effected by including an additional deduction in the company's corporation tax computation, calculated from the RIPP figure.

1.22. Although the resulting profits chargeable to corporation tax are then charged at the normal corporation tax rate, the extra deduction has the effect of reducing the rate.

1.23. If the Patent Box RIPP calculation produces a negative figure, then there is no change to the company's normal corporation tax computation. However, the negative amount of RIPP must be offset against any other RIPP of the company derived from a different trade, of other group companies, or against future RIPP of the company or other group companies in working out Patent Box benefits in these cases.

1.24. A company cannot benefit immediately from the Patent Box on profits from items pending patent approval. But, for up to six years before grant, the company can calculate what the relevant RIPP would have been had the patent been granted at that time. These amounts are aggregated over the six years, and then they can be added to the RIPP of the year in which the patent is granted when calculating the Patent Box deduction.

(iv) Other Aspects of the Patent Box

1.25. There are a number of rules to determine how patented and non-patented items sold or licensed together, are taken into account in arriving at RIPI.

1.26. In some cases it may be obligatory for the company to "stream" its profits rather than apportion them.

1.27. The Patent Box has an anti-avoidance rule to prevent unreasonable tax benefits arising from tax- motivated schemes which aim to create mismatches of income and expenditure or to avoid particular provisions of the Patent Box. And there are anti-avoidance rules to stop commercially irrelevant patented items being included in or with a product or spurious exclusive rights being added to licence agreements solely to enable income to qualify.

1.28. There are rules enabling partnerships and cost-sharing arrangements to qualify for the Patent Box.

1.29. In some circumstances RIPP in the first four years for which a company qualifies for the Patent Box may be reduced by additional deemed R&D expenditure.

1.30. The full benefits of the Patent Box are being phased in over a number of years from April 2013.

Draft Legislative Structure of the Patent Box

1.31. It is proposed to include the main Patent Box legislation as Part 8A of CTA 2010, between other parts specifying the rules for the corporation tax treatment of profits from particular activities (oil and gas exploration and leasing of plant or machinery).

1.32. This primary legislation is set out in 7 chapters:

- Chapter 1 provides an introduction;
- Chapter 2 sets out qualifying conditions for a company;
- Chapter 3 provides the main rules for calculating profits eligible for the reduced rate ("relevant IP profits");
- Chapter 4 specifies a more bespoke alternative method of identifying these profits ("streaming");
- Chapter 5 provides rules for dealing with companies that have relevant IP losses in some periods ("relevant IP losses");
- Chapter 6 contains targeted anti-avoidance rules to prevent abuse of the regime; and
- Chapter 7 sets out the rules regarding elections into the Patent Box regime, its application to partnerships and cost-sharing arrangements and provides definitions.

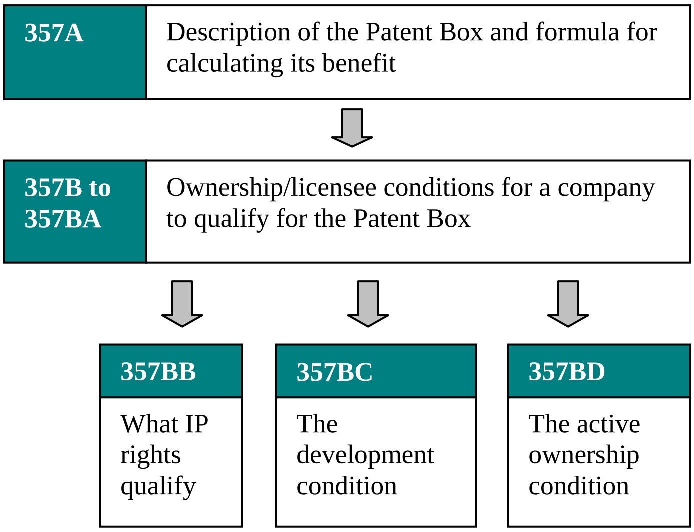
1.33. Additionally a Treasury Order will specify certain other rights that will qualify for the Patent Box.

1.34. The remainder of this Technical Note goes into more detail about the legislation, following the legislative structure described above.

1.35. An outline summary of the legislative structure is provided at the back of this Technical Note.

Chapter 2 – Qualifying for and Giving Effect to the Patent Box

2.1 The structure of this part of the legislation is set out below:



357A – Election into the Patent Box

2.2 Companies can elect into the Patent Box if they satisfy qualifying conditions about ownership of patent rights. These are set out in sections 357B to BD.

2.3 If the company elects into the box, it is entitled to an additional trading deduction in computing its corporation tax profits. The deduction is the amount obtained from the formula set out in 357A(3).

2.4 The deduction in 357A(3) achieves the same result as charging the relevant IP profits of the company (which are the profits "in" the Patent Box) directly at 10%.

For example, if a company has trade corporation tax profits of £1000, which qualify in full for the Patent Box when the main rate of tax is 23%, then instead of arriving at a tax charge of £100 by multiplying £1000 by 10%, the calculation proceeds as follows:

Profits of Company's trade chargeable to CT	1000
Patent Box Deduction 1000 x (23-10)/23	565
Profit Chargeable to corporation tax	**435**
Tax Payable £435 x 23%	**£100**

2.5 This approach is used, rather than directly charging the relevant profits at 10%, to avoid complications if the company claims losses or other reliefs and to simplify the way the Patent Box will be administered on corporation tax returns.

2.6 The formula is the same for companies charged at the main rate of corporation tax and for companies is charged at the small profits rate, or at the main rate with marginal relief. This means that in some cases Patent Box profits may be charged at a little below 10%.

2.7 If, rarely, a company has more than one trade the Patent Box deduction is calculated for each trade separately. If any one trade produces a negative amount of relevant IP profit, referred to in the legislation as relevant IP losses, this will need to be deducted from the relevant IP profits of the other trades, under 375E to 375EE (see chapter 5 below).

357B - Qualifying company conditions (holding, licensing–in, developing and managing IP)

2.8 Patent holders may wish to license their invention for others to develop. The Patent Box is designed to benefit both the licensor and any licensee who has been given exclusive rights under which it develops and exploits the invention.

2.9 A company can elect into the Patent Box if it qualifies by holding, or licensing-in exclusively, IP rights of the types specified under the legislation. This is so long as:

- it satisfies the "development condition" in relation to those rights, so that the rights count as "qualifying IP rights"; and
- if it is a member of a group, it satisfies the "active ownership" condition in relation to substantially all of its qualifying IP rights.

2.10 The meaning of an exclusive licence is set out in 357BA (explained below).

2.11 In the normal situation, a company can elect into the Patent Box if it has qualifying IP rights at any time in the relevant accounting period. This is "Condition A" in 357B.

2.12 To cater for situations:

- where a company disposes of qualifying IP rights, but receives income from the disposal in a later period; and also
- where income is received as a result of infringement of a patent, but not until after the expiry of that patent.

357B also allows a company to qualify for the Patent Box if it has previously elected into the Box, and is taxed in a current period on income derived from an event at that earlier time concerning a then qualifying IP right. This is "Condition B".

357BA – Meaning of exclusive licence

2.13 The key aim is that to qualify for the Patent Box, a licensee must have some unique rights to develop, exploit and defend rights in the invention.

2.14 The rules however aim to recognise that a patent holder may grant licence rights in different territories or in different fields of application.

2.15 So a licensee does not need to be given all rights in the patented invention. The rights might, for instance, be limited to development and exploitation in a particular application. An example is below

- An inventor develops and patents a chemical compound, to be used on its own in a product that the inventor manufactures and sells. Recognising that other companies may wish to develop other applications by mixing the compound together with other chemical ingredients, it grants a licence to another company to develop such mixtures. But not the right to sell the unmixed compound.
- The licensee will be treated as having an exclusive licence provided that the licence specifies that only the licensee, or persons authorised by it, have the right to exploit the compound as mixtures.
- If the licence does not specify that the right is exclusive, perhaps to allow others to be licensed in future to develop similar mixtures, then the licence will be non exclusive.

2.16 To be an exclusive licence, the licence must give the licensee exclusivity for its rights extending throughout an entire national territory at least. So a licence that gives sole rights to manufacture and sell an item within part of a country only, as opposed to the whole country, will not be exclusive.

2.17 The draft legislation restricts the required exclusivity to persons who carry on the same or similar description of trade. This is to acknowledge that different licensees may be given superficially very similar (and therefore potentially not exclusive) rights to develop IP but in very different applications. The legislation is intended to allow different concurrent licensees to each be eligible for the Patent Box in this situation.

2.18 If similar rights to develop the IP or a product incorporating it are granted to two or more persons working in the same field of application, then HMRC considers it is reasonable to regard them as carrying on the same or similar descriptions of trade for this purpose, irrespective of the means of exploitation of the development or the wider nature of their trades.

2.19 Additionally the licensee must either:

- be able to bring infringement proceedings to defend its rights in the patented invention, or (if the patent owner retains control over defence of the patent); or

- be entitled to most of the damages relating to its rights that would be awarded in successful proceedings.

2.20 Groups of companies may hold legal ownership of a portfolio of patents in one company. The legal owner may confer rights in particular patents on another group company to develop and exploit the patent and derive income from it. But it may retain some rights it needs to manage its portfolio. To accommodate this, 357BA(4) and (5) allow the other group company to elect into the Patent Box as if it held an exclusive licence, if it has all rights in the patented invention, or all rights apart from rights to enforce, assign or licence the patent.

357BB – What patents and other rights can qualify

2.21 Patents granted by the UK Intellectual Property Office ('IPO') under the Patents Act 1977 and patents granted by the European Patent Office can qualify for the Patent Box.

2.22 Additionally if a patent is not granted by the UK IPO, on grounds of national security or public safety, then the applicant is to be treated as if it had been granted the patent.

2.23 The scope of the Patent Box also extends to rights similar to patents. The legislation includes an Order of the Treasury published on 6 December 2011. This Order specifies rights in addition to those set out in section 357BB, the income from which is subject to the tax regime in Part 8A. This power is being used to include the additional rights set out below:

- supplementary protection certificates, ('SPC') which are granted by the UK Intellectual Property Office or by the European Patent Office, including paediatric extensions;
- UK and European Community Plant Variety rights; and
- certain UK and European regulatory exclusivity rights, for example regulatory data exclusivity rights granted in respect of medicinal, veterinary and plant protection products, and marketing exclusivity granted to orphan status medicines and medicines for paediatric use.

357BC – The development condition

2.24 The key aim of the development condition is to limit the Patent Box to companies and groups which have been properly involved in the innovation lying behind the patent or the application of the patented invention.

2.25 The definition of qualifying development set out in 357BC(7) (8) and (9) requires:

- creating, or significantly contributing to the creation of, the patented invention; or
- performing a significant amount of activity to develop the patented invention, any product incorporating the patented invention, or the way in which the patented invention may be applied.

2.26 Whether activity is significant will be determined in the light of all the relevant circumstances. Simply acquiring rights to and marketing a fully developed patent or invention, or product incorporating the invention, will not be sufficient.

2.27 However there may be a number of ways in which activity could be significant. For example it could be coming up with the breakthrough idea. Or it could be work to test or enhance the viability or usefulness of the idea. A contribution could be significant by virtue of the costs, time or effort incurred. Alternatively it could be significant due to the value or impact of the contribution.

2.28 In certain circumstances a company may acquire fully developed qualifying IP as part of a wider project. For this reason the development condition can be met if the development activity took place before or after acquisition of or licensing-in the qualifying IP.

- For example, a company conducts a project to develop a more efficient light bulb and undertakes a significant amount of research and development. But then the project discovers that the design of the light source they intended to use is already the subject of a third party patent which the company then acquires.
- The development activity will satisfy the development test, even though it took place before acquiring the patent.

2.29 There are four potential ways that a company can pass the development condition.

2.30 The first (Condition A) is where a company has itself carried out the qualifying development activity. The company may be a singleton company, or a member of a group. If the latter it must have remained in the same group since undertaking the qualifying development: this prevents company sales being used to "envelope" sales of patent rights.

2.31 Condition B deals with changes of ownership. It allows a company that continues with development activity of the same description (although not necessarily on the same invention) for at least 12 months after a change of ownership to continue to qualify.

2.32 The development condition is extended further in group situations by Condition C. A company within a group satisfying the ownership requirements can qualify if another company in the group has carried out the qualifying development activity.

2.33 This accommodates arrangements within groups where for example one group company carries out R&D activity, but the IP arising out of that activity is owned by, or transferred to, another group company which holds the group's intangible assets.

2.34 Condition D extends Condition B to allow a group which acquires a company which developed the patent to transfer the qualifying IP to another company in the group. Activity done in the acquired company before acquisition can satisfy the development condition if the acquired company continues with the same description of qualifying development for at least 12 months after acquisition.

2.35 357BC(6) ensures that conditions B and D can be satisfied during the relevant 12 month period.

2.36 A company may meet the development condition for some of its IP rights but not for others. If so, then the company will still be a "qualifying company" able to elect into the Patent Box. However, 357B(4) ensures that only those rights for which the company meets the development condition are "qualifying IP rights" which may give rise to relevant IP profits.

357BD – The active ownership condition

2.37 The key aim of the active ownership condition is to ensure that the company qualifying for the Patent Box is not a passive IP holding company, but must either have developed the IP itself or be actively managing it. If the company does not meet the active ownership condition for its portfolio of qualifying IP rights then it will not be able to elect into the Patent Box.

2.38 Only qualifying IP rights (i.e. rights of a type listed and for which the company meets the development condition) are considered when determining whether the active ownership condition is met. The amount of development or management activity carried out in relation to any other IP rights is irrelevant.

2.39 The test does not apply for singleton companies outside a group, because the company will itself have to meet the development condition outlined above. If it does so it will have to have undertaken significant activity and so will not be passive.

2.40 However, a company which satisfies the development condition only because of the activity of a fellow group company must show that it plays an active role in managing the qualifying IP rights it holds. This means it must be involved in the planning and decision making activities associated with developing and exploiting substantially its qualifying IP portfolio.

2.41 Activities such as deciding on whether to maintain protection in particular jurisdictions, grant licences, research alternative applications for the innovation or licensing others to do so count as management activity.

2.42 Whether what is done is a significant amount of management activity is to be determined in the light of all the relevant circumstances, given:

- the resources the company employs;
- the breadth of its responsibilities for the IP; and
- the significance and impact of the decisions and plans it, as opposed to other group companies, makes in relation to that IP.

2.43 It is hoped that normally it will reasonably clear in practice whether the company's activity is significant.

2.44 The company does not necessarily have to take all decisions relating to the IP's management, particularly if normal group governance requires reference to the parent Board. But it must be actively involved in making plans and decisions and have clear substantive responsibilities. Neither does there have to be activity in each accounting period in relation to each right, if this is commercially unnecessary for the group's holding of that right.

Chapter 3 – Calculating Profits Eligible for the Patent Box Rate

3.1 None of the rules in Chapter 2 determine whether any profits of the qualifying company in an accounting period qualify for the reduced rate.

3.2 This is achieved by Chapter 3 of the draft legislation. It provides rules to calculate the part of its profit that will be eligible for the Patent Box rate.

3.3 The structure of this part of the legislation is set out below:

357C	Outlines the steps in the calculation, starting from the relevant IP income generated from the company's patents or patented inventions and the taxable profits of the company's trade

Steps 1 to 3	357CF & 357CG	357CB to 357CE
Apportions profits of the trade, pro-rata to the proportion of: relevant income from patents / total gross trade income	Specifies that trade profits are before net finance costs and any enhanced R&D expenses	Defines relevant IP Income, including (amongst others) income from sales of items and notional royalties
Note: 357D to DC provides an alternative calculation	Reduces profits for the first four years in the Patent Box by earlier R&D expenditure in some instances	Excludes certain income & apportions mixed income sources.

See paragraphs 3.4 to 3.71 of this Technical Note

Step 4	357CH and 357CI
Deducts a "routine return" figure from the amount obtained from steps 1 to 3 above to give "qualifying residual profit" (QRP)	Sets routine return at 10% of prescribed expenses, excluding R&D

See paragraphs 3.72 to 3.81 of this Technical Note

Step 5 and 357CJ	Step 6 and 357CK to 357CM
Specifies RIPP to be 75% of QRP if • the company elects • the claim is below the qualifying threshold	Deducts an arms length marketing assets return from QRP, less any actual payment made for the relevant marketing assets

See paragraphs 3.82 to 3.111 of this Technical Note

357C – Calculation of relevant IP profits

3.4 There are three stages to calculate the profit to which the Patent Box tax rate applies. These are broken down in the legislation into a total of 6 steps.

3.5 A seventh step may apply if profits were made previously from inventions awaiting grant of a patent. This is dealt with later in this Technical Note.

3.6 The first stage is steps 1 to 3 in the draft legislation. This:

- starts with the "total gross income" of the trade, which includes revenue receipts; and any profits from the realisation of trade intangibles or patent rights, but excludes any finance income;
- works out the proportion of RIPI (relevant IP income that forms part of total gross income) to the total gross income of the trade; then
- attributes the same proportion of the profits of the trade (adjusted by excluding finance returns and costs, and R&D additional deductions) to the RIPI.

3.7 The second stage is the removal of a routine return on expenses, described at step 4 in the legislation, from the attributed profits to get a figure of "Qualifying Residual Profit (QRP)".

3.8 The third stage, steps 5 and 6 in the draft legislation, removes a marketing assets return from QRP, or 25% of the QRP figure in some cases. The remainder is then the "Relevant IP Profits" (RIPP) which are subject to the reduced rate.

3.9 Note that as an alternative, the company can allocate profits to RIPI using the "streaming" rules set out in Chapter 4 of the draft legislation. And in some circumstances the company has to use this approach.

357 CA to 357 CG - Steps 1 to 3 of 357C:

3.10 Key aspects to steps 1 to 3 are:

- the definition of total gross income;
- the classes of income that are RIPI, and the types of income that are excluded from being RIPI. Specifying this includes defining items whose sale generates the relevant IP income;
- the concept of notional royalties. This enables some part of otherwise non-qualifying types of income to be treated as qualifying income. An example is income from services and processes that are carried out using patented inventions; and
- adjustments which need to be made to taxable profits before apportionment. In the first four years after electing into the Patent Box this may include adjustments which take earlier R&D costs into account

if actual R&D expenditure has fallen to 75% or less than its level before the election.

357CA – Total Gross income of a trade

3.11 The total gross income of the trade is the aggregate of:

- amounts that are recognised as revenue under GAAP and taken into account as credits in calculating the profits of the trade in an accounting period. IAS 18 defines revenue as the gross inflow of economic benefits such as sales of goods and royalties;
- credits brought into account for tax purposes on realisation of intangible assets under the intangible fixed assets rules in chapter 4 of Part 8 of CTA 2009 (sales proceeds less allowable asset costs if any); and
- profits from the sale of pre-2002 patents patent rights charged to tax in the accounting period under section 912 of CTA 2009. The company can choose to bring those profits into charge over six years. If so, total gross income each year will include the amounts charged in each accounting period.

3.12 Finance income is excluded from the Patent Box. Any trading loan relationships credits are therefore excluded from total income for the Patent Box calculation. In this respect finance income also includes:

- any amounts that GAAP treats as arising from a financial asset (such as dividends or the sale of shares); and
- any return that is economically equivalent to interest (using definitions set out in s486B CTA 2009 (disguised interest)).

357CB – Relevant IP income (RIPI)

3.13 Relevant IP income is defined in 357CB. In many cases “RIPI” and “relevant IP income” will be synonymous. However RIPI is defined in 357C and in order for relevant IP income to be RIPI it must be included in the total gross income of the trade.

3.14 Therefore, finance income cannot be RIPI, as it is excluded from total income. Similarly any non-taxable income cannot be RIPI.

3.15 Relevant IP income can arise from four different ways of exploiting IP rights:

Head 1: Income from sale of qualifying items etc

3.16 Head 1 is income from the sale of:

- qualifying items;
- items incorporating a qualifying item, (or designed to incorporate a qualifying item, if sold together with that item as a single unit and at a single price); and
- items wholly or mainly designed to be incorporated into a qualifying item or an item incorporating a qualifying item.

3.17 A qualifying item is an item which is protected by a qualifying IP right. For a patent, this will be the patented invention.

3.18 The June 2011 Consultation Document explained that as well as sales of the invention itself, the Patent Box is intended to extend to income from the sale of items that include the patented invention and to spare parts.

3.19 To achieve this, the draft legislation uses the concepts of items incorporating a qualifying item and items designed to be incorporated into a qualifying item.

3.20 In HMRC’s view, to be incorporated, the item must be physically part of the larger item and intended to be so for its operating life. Examples of what this might mean in practice are below:

- A patented printer cartridge is designed to be inserted in a printer and once installed not to be removed until empty, at which point it will be replaced. The printer cartridge will be incorporated in the printer. Income from the sale of a printer including the printer cartridge (whether the cartridge is installed or included separately in the box with the printer as part of a single package) can therefore qualify as RIPI, even if there were no patent over the printer itself.
- Conversely, if the printer includes a patented invention and the printer cartridge does not, then sales of the cartridges on their own will qualify as items wholly or mainly designed to be incorporated into the printer.

- In contrast a patented DVD may be designed to work with a wide variety of DVD players and after each use is intended to be removed. So it is not incorporated in the DVD player, or designed to be incorporated.
- So unless the DVD player is patented or includes a patented invention, including a patented DVD with it in a sale will not qualify the income from the player as RIPI. And similarly, if the DVD player is patented and DVDs are not, sales of the DVDs will not produce RIPI.

3.21 Items wholly or mainly designed to be incorporated into qualifying items or products including qualifying items are included to encompass sales of a variety of bespoke spare parts etc. The company must hold the qualifying IP rights in the item the spare parts are designed for.

Containers and packaging

3.22 The contents of a container will not normally be incorporated in that container, as they will be intended to be removed from it for use.

3.23 But, to avoid doubt, 357CB specifically defines packaging and its contents to be separate items, unless the packaging performs a function other than just the normal function of packaging: to contain, protect, facilitate delivery or handling of an item or to enable the item to be presented in a particular way.

3.24 The reason for this is primarily to deal with cases where a non-patented product is sold in a patented container or packaging.

3.25 Packaging may in some instances however be an integral part of the product throughout its operating life, if it has a particular function aside from its packaging function. To deal with this, the draft legislation allows packaging to be regarded as incorporated with its contents if it performs a function that is essential to allow its contents to be used in the particular way they are intended to be used. An example is below:

- A medical inhaler may include a sleeve, a canister and the active ingredient plus gas and other contents inside the canister to ensure an effective and measured dose of the active ingredient is administered.
- It may be that each of these items: the sleeve, the canister and the contents of the canister are patented. But even if this is not the case, income from sale of the sleeve, canister and contents together will be within Head 1 if any one of the components is patented. The packaging rule will not exclude either the sleeve or the canister, because they fulfil an essential function in the proper administration of the drug.

3.26 Where the packaging is not patented but the contents are, there will generally be no need in practice to distinguish income from packaging separately. 357CE(6), explained later in this Technical Note, in most instances will allow the packaging to be ignored and all income to be treated as arising from the contents.

3.27 Note also that if packaging is patented, and materially contributes to the sale value of a non-patented product, then 357CE will allow the income that is reasonably attributable to the packaging to qualify as RIPI.

Head 2 – Licence fees or royalties for granting rights over qualifying IP rights

3.28 Head 2 is licence fees or royalties received for a right granted over qualifying IP of the company (including where the company grants rights out of an exclusive licence it has over qualifying IP).

3.29 It also includes licence fees or royalties from granting of rights over non-patented items, if the purpose of granting of those rights is the same as for the rights over the qualifying IP

3.30 For example:

- The owner of the patent rights over a silicon chip licenses others to manufacture and sell products containing the chip. At the same time it licenses them to use designs, trademarks, know how and technical information to allow them to manufacture and market those products effectively.

- These other rights granted are not themselves in respect of qualifying IP rights. But they will be other rights licensed for the same purpose as the licence over the qualifying IP right. Fees and royalties in respect of these other rights will therefore be relevant IP income in the same way as fees and royalties received in respect of the right to exploit the patented invention.

Head 3 – Proceeds of realisation of a qualifying IP right.

3.31 Head 3 is the income from the sale or other disposal of a qualifying IP right or exclusive licence.

3.32 RIPI under this Head will be the amounts included in total gross income.

3.33 So for post-2002 IP, RIPI will therefore normally be the taxable credit equal to the excess of proceeds of realisation over the accounts carrying value of the qualifying IP right, as set out in sections 735 and 736 CTA 2009.

3.34 And for disposals of pre-2002 patents, where the company chooses to spread the profit on a disposal for tax over a six year period, RIPI will be the part brought into charge to tax in the relevant year.

Head 4 – Infringement income.

3.35 Head 4 is compensation payable to the company from an infringement or alleged infringement of the company’s qualifying IP rights.

3.36 The company can qualify (Condition B of 357B) and the income can be relevant IP income even if it is received after expiry or sale of the relevant patent right, if the infringement took place when the right was a qualifying IP right and the company was then elected into the Patent Box.

3.37 Where a company receives compensation that relates partly to a period when both the company and the rights were qualifying, and partly for a period when one or both these were not qualifying, then a reasonable apportionment of the receipt should be made. A reasonable apportionment will also need to be made for any compensation which relates to a period when the company was not elected into the Patent Box, including to any period before 1 April 2013.

357CC – Notional royalties

3.38 The key aim of the notional royalty provisions is to deliver Patent Box benefits to a company using its patented invention in a way that does not generate RIPI, but. does result in the company deriving income and profits. This was proposed in the June 2011 consultation document, in particular to cover patents used in processes that create non-patented products or to provide services.

3.39 Examples could be:

- A patented tool is used in the manufacturing process of non-patented items which are sold by the company.
- An airline company may develop a flight simulator using one or more patented components. The simulator is used both to train its own pilots, and also generates income by providing a training facility to pilots of other airlines. The airline's own ticket sales and the direct income from training facility provision are both non-RIPI income that for the purposes of the notional royalty provision is "IP- derived income".

3.40 357CC applies only to patents: it is not thought that qualifying data exclusivity and plant variety rights will be used in a way that generates income that isn't RIPI.

3.41 The draft legislation allows part of the income generated (termed "IP-derived income") to be treated as RIPI.This is an amount equal to the royalty that would be paid to an independent owner of the qualifying IP rights for the company's exclusive use of those rights to generate the IP-derived income.

3.42 Some assumptions must be made in calculating this amount, to specify certain circumstances which would affect the level of royalty payable at arm's length.

3.43 These set out in 357CC (7). Some points to note are set out in the following paragraphs.

3.44 In addition to making the assumptions in 357CC(7), the notional royalty must be calculated in according with Article 9 of the July 2010 OECD Model Tax Convention and the OECD's Transfer Pricing Guidelines, or any successor documents.

3.45 The licence is assumed to be entered into on the later of the first day of the accounting period and the day the company obtained the IP right. This is so that in each accounting period the royalty corresponds closely to the current value of the rights, without requiring recalculation on a more frequent basis if the value changes during the accounting period.

3.46 In practice it should not normally be necessary to determine a new royalty rate for each new accounting period if none of the relevant facts and circumstances have changed from a previous accounting period.

3.47 The notional licence is assumed to be granted for a period matching the period for which the company actually holds rights. This allows the amount of the royalty to properly reflect the actual value of the patent rights: a longer term licence tends to be more valuable, on an annual basis, than a shorter term but otherwise equivalent licence.

3.48 The notional royalty must take the form of a fixed-rate periodic royalty in order to unambiguously match payments under the licence to the accounting periods in which the IP-derived income is generated. The royalty must be calculated as a percentage of the IP-derived income from the patent rights for their remaining life. This precludes any lump-sum upfront or milestone payments, and tiered or front-loaded or back-loaded royalties which could distort the Patent Box calculation in particular years.

3.49 The royalty is only calculated based on income that is not itself RIPI to prevent double-counting. It is not calculated on “excluded income” because no part of this income can qualify for the Patent Box.

3.50 The notional royalty can never be greater than the IP-derived income from which it is calculated.

357CD – Excluded income

3.51 Certain types of income which might otherwise qualify as RIPI are excluded. These are:

- any income arising from oil extraction activities or oil rights (as defined in part 8 of CTA 2010); and,
- income from exploiting non-exclusive licences.

3.52 Licences which include some exclusive rights along with other rights which are not exclusive are treated as two separate licences, one an exclusive licence that does not confer any rights other than those that are exclusive, and the other a ‘non exclusive licence’ which confers the balance of non exclusive rights. Income from these ‘non exclusive licences’ is not RIPI.

3.53 For example:

- A company may hold non-exclusive rights under a licence to improve, manufacture and sell a new patented laser device to use in fibre-optics. It may also have an exclusive licence to use the patented technology to develop an entirely new application in medical diagnostics.

- Income from the latter application would be relevant IP income, but income from the former would be excluded income.

357CE – Mixed sources of income

3.54 This section deals with the following situations:

- items which would give rise to RIPI are sold together with other items as part of a single unit and/or for a single price;
- a single agreement is made which covers the sale of items or the grant of rights some of which would give rise to RIPI and some of which would give rise to other income.

3.55 Income arising in these circumstances is designated as either mixed income or income paid under a mixed agreement. Such income should be apportioned between qualifying and non qualifying elements on a just and reasonable basis.

3.56 Where any non-qualifying elements of such income comprise only a trivial proportion of it, then the whole of the income is to be regarded as RIPI, so no apportionment will be necessary.

3.57 “Trivial” is not defined, but in practice this can be assumed where realistically the cost and expense of trying to make an apportionment would be disproportionate to the likely impact on the Patent Box calculation. As noted earlier in this Technical Note, this will generally be the case for packaging around a patented product, which will usually have minimal value.

357CF– Adjustments to profits or losses of trade

3.58 Certain adjustments must be made to the taxable profits of the trade for the purposes of computing relevant IP profits. These are:

- R&D relief: the amount of any additional deduction provided by way of R&D tax credit relief is added back to the profits featuring in the Patent Box calculation, so that none of the benefits of the relief is clawed back by the Patent Box;
- Trading loan relationship credits, and other financial returns which are economically equivalent to interest or accounted for as arising from financial assets. These are deducted as they are not eligible for the Patent Box; and

- Trading loan relationship debits, which are added back.

3.59 This adjustment is to be made before the profits are apportioned using the ratio of RIPI to total gross income at step 2 of the formula used to arrive at relevant IP profits set out in S357C.

3.60 It is perhaps worth noting, for clarity, that this of course is **only** done in order to compute Relevant IP profits. The only adjustment that will be made to the actual taxable profits of the trade as a result of electing in to the Patent Box will be the Patent Box deduction referred to in 357A.

357CF(7) & (8) and 357CG – Pre-commercialisation expenses and the R&D expenditure condition

3.61 Paragraph 4.32 onwards of the June 2011 consultation proposed that there should be a mechanism to take account of prior year R&D costs if current year costs do not provide a reasonable proxy for development costs of current products.

3.62 The key aim of 357CF(7) is to provide this mechanism.

3.63 It calculates the average amount of R&D expenditure in the four years before the election into the Box. It applies if the actual amount of R&D expenditure in an accounting period starting within the first four years after entering the Patent Box is less than 75% of the average amount. If an accounting period is less than 12 months long, the average amount of R&D expenditure is proportionately reduced.

3.64 Where this is the case, the actual R&D expenditure is increased to 75% of the previous average annual R&D expenditure, before the profits of the year are apportioned in step 2 of the calculation set out in S357C to arrive at relevant IP profits.

3.65 R&D expenditure for this purpose is the expenditure recognised in the company's statutory accounts under generally accepted accounting practice in the UK. The relevant UK accounting standard will be SSAP 13 or where the company has accepted International Accounting Standards IAS 38.

3.66 If the company has traded for less than four years before electing into the Patent Box, the average amount of R&D expenditure is calculated over the period between the trade commencing and the first day of the first accounting period for which the company comes into the regime.

3.67 The figure is calculated using the formula 365 x E/N, where E is R&D expenditure over the whole of the relevant period and N is the number of days in that period.

3.68 The amounts of actual R&D expenditure in the four years after a company elects in to the Patent Box may fluctuate. If actual R&D expenditure in any of the first four years after election exceeds the average R&D expenditure, the excess can be carried forward.

3.69 This carried forward amount can be added to actual R&D expenditure in future years in testing whether the company meets the 75% condition in those years.

3.70 If it takes the company's actual R&D expenditure later in one of the four years to over 75% of the average R&D expenditure, when it otherwise wouldn't then a part equal to the difference between that 75% figure and the actual expenditure in the year cannot be further carried forward. The remainder can.

For example: a company has 'average R&D expenditure' of £1,000. 75% of this is £750.

Its results for the first four AP's (each of 12 months) after electing in to the regime are:

AP	1	2	3	4
Total Gross Income	£3,000	£10,000	£15,000	£20,000
R&D	£1,500	£800	£350	£200
Other Costs	£800	£5,200	£11,150	£15,200
PCTCT	£700	£4,000	£3,500	£4,600

- In AP1 actual R&D exceeds 'average R&D expenditure by £500, so this £500 can be carried forward.
- AP2's actual R&D is £800 which is less than 'average R&D expenditure' but greater than 75% of 'average R&D expenditure' so no adjustment is required. £500 continues to be carried forward.
- In AP3 actual R&D is only £350, which is £400 below the 75% threshold. The brought forward £500 is added to the actual amount so there is no need to make any adjustment. £400 of this cannot be carried forward further, but £100 can.
- In AP4 actual R&D spend falls again to £200. The brought forward £100 can be treated as R&D spend of AP 4. As the total is £300, for patent box purposes the R&D spend in AP4 is deemed to be £750. The profits of the trade for the purposes of step 3 of 357C will become:

AP	4
Turnover	£20,000
R&D	£750
Other Costs	£15,200
Step 3 profits	£4,150

3.71 If, despite adding the brought forward amount, the R&D expenditure in one of the later years is less than 75% of the average, then the average figure is substituted for the actual. The brought forward amount can be carried forward to the next year.

357CH and 357CI – The routine return figure and routine expenses

3.72 A routine return is the profit a business might be expected to make if it did not have access to unique IP and other intangible assets. This routine return element must be deducted from the profit attributed to RIPI to arrive at the amount of that profit that is attributable to the intellectual property (both patent-related IP and other, such as marketing assets, IP).

3.73 A cost plus methodology is a recognised way to determine an arms length return that might be expected from a trader without access to unique IP.

3.74 The Patent Box adopts, for simplicity, a 10% return on certain specified costs as a representative routine return in respect of businesses across all sectors.

3.75 The routine return is calculated by:

(i) aggregating routine expenses (as defined in 357CI, see below) deducted in calculating the profits of the trade (excluding any R&D expenses or loan relationship debits) and taking 10% of that figure; and

(ii) apportioning the result, by applying the same percentage of RIPI/ Total Gross Income used to apportion the profits of the trade in Step 2 of the calculation in 357C.

3.76 The resulting amount is deducted at step 4 of the formula outlined at 357C to gives the “Qualifying residual profit” (QRP) of the company.

3.77 Routine expenses are defined in 357CI as amounts in the categories below, excluding any loan relationship amounts and R&D expenses:

- any allowances under CAA2001. This will be the amount of any such allowances deducted from trading income in arriving at the taxable profits of the trade; since only such amounts will have been ‘brought into account in calculating the profits of the trade’;
- premises costs – all deductible expenses incurred in respect of land and premises which the company occupies. This will include rent, rates, repair and maintenance, water fuel and power costs etc;
- personnel Costs – this includes any expenditure incurred by the company in respect of directors or employees. It also includes amounts paid in respect of externally provided workers supplied to the company as defined by S1128 of CTA 2009;
- plant and machinery costs – this includes any deductible costs associated with plant and machinery owned or leased by the company (e.g. costs of leasing, constructing, modifying, maintaining, servicing, operating etc); and

- miscellaneous services – computer software costs, consultancy and professional costs, telecommunications, postal, computing, transport and waste disposal services.

3.78 Routine expenses incurred by another group company on behalf of the Patent Box company are included as if they had been included directly. However if the other group company provides a service to the Patent Box company, costs incurred to provide this service will not be treated as routine expenses of the Patent Box company as they are incurred as part of the trade of the other company.

3.79 R&D expenses are excluded from the calculation. This recognises that these expenses are likely to have a direct correlation to the creation and development of qualifying IP. The R&D expenses excluded are the amounts on which R&D tax credits are given, plus any additional deduction given by the R&D tax credit regime.

3.80 If, in one of the first four years after electing into the box, the company's R&D expenditure is increased to the average R&D expenditure of the four years before electing into the box, the additional amount brought into account is also excluded.

3.81 At step 4 of the calculation outlined at 357C, the routine return is deducted from the profit attributed to RIPI to arrive at a figure called the "Qualifying Residual Profit" (QRP) of the company.

357CJ - Election for small claims treatment

3.82 The QRP represents the part of the profits of the trade that relates to qualifying IP rights and also to ability to access other unique IP or intangible assets such as brand and other marketing assets. The regime aims to ensure that the profits attributable to these other types of IP are excluded from the Patent Box.

3.83 The legislation provides two possible methods for determining how much of the QRP of a company for an accounting period represents profit from qualifying IP rights and how much relates to brand and marketing assets. The latter part of the profit is deducted from QRP, with all remaining profits being relevant IP profits ("RIPP") which are then used to calculate the 357A Patent Box deduction.

3.84 The simpler of these two methods allows company to elect to adopt a formulaic approach.

3.85 This approach, set out in 357CJ, stipulates the relevant IP profits for the accounting period to be the lower of two amounts:

(i) 75% of QRP ; or

(ii) The small claims threshold (£1 million).

3.86 A company with QRP of less than £1.3m may of course believe that it does not in reality exploit any marketing assets or the value of any marketing assets is only small.If it is able to demonstrate that this is so, applying the provisions at 357CK to 357CN may be relatively straightforward and it may choose not to elect for small claims treatment.

3.87 Conversely, it is possible that a company with QRP significantly in excess of £1.3m may still wish to opt for small claims treatment to make the RIPP calculation simpler, provided that it does not wish to claim any more than £1 million as relevant IP profits.

357CK to 357CM - Marketing assets return, notional marketing royalty and actual marketing royalty

3.88 The provisions to exclude the return from marketing assets are intended to focus the benefit of the regime on technologies covered by relevant IP rights. They aim to exclude the sometimes very substantial profits that can be generated using established brands. The legislation is limited to marketing assets in order to minimise computational complexity while excluding what is believed to be the largest source of profit not directly related to qualifying IP rights.

3.89 If a company does not elect for small claims treatment, it must deduct a marketing assets return figure from QRP to arrive at relevant IP Profits (RIPP).

3.90 The legislation uses two figures, the notional marketing royalty (NMR) and the actual marketing royalty (AMR) to calculate the profit attributable to marketing assets.

3.91 However if AMR is greater than NMR, or the difference between the two is less than 10% of QRP for the accounting period, the marketing assets figure is nil. This rule is intended to avoid expensive evaluation of the value of marketing assets where they make only a small contribution to overall profit.

357CL – Notional Marketing Royalty

3.92 The NMR is the appropriate percentage of the relevant IP income for the accounting period that a company would pay a third party for the exclusive right to exploit the relevant marketing assets if they were not otherwise able to exploit them.

3.93 As an indicator of what, subject to consultation, might be the appropriate categories of marketing assets the legislation uses a definition that the marketing assets concerned are those that are exploited in generating the relevant IP income which come under the following headings:

- any trade mark (registered or unregistered);
- signs or indications of geographical origin of goods or services; and
- information about actual or potential customers.

3.94 The definition of trade mark referred to in the legislation includes any sign capable of distinguishing goods or services of one undertaking from those of other undertakings. This includes words (including personal names), designs, letters, numerals or the shape of goods or their packaging.

3.95 The legislation requires the assumption to be made that an agreement can be made for the company to exploit the assets to the exclusion of all others including the notional owner, even if the assets cannot in fact be separately transferred or assigned.

3.96 In determining what an arms-length royalty will be, and as for the notional royalty described earlier in this note on page 22, certain assumptions need to be made to set the conditions under which the parties are deemed to transact.

3.97 These assumptions include:

- the company and the notional IP owner are dealing at arms length;
- the company have the right to exploit the marketing assets, to the exclusion of all others including the notional IP owner;
- the right to exploit the marketing assets is conferred at the start of the accounting period, or if later when the relevant assets were acquired;
- the rights to the assets being notionally considered are the same as in fact exist;
- the appropriate percentage figure for the royalty, as a percentage of relevant IP income is determined at the start of the accounting period and it will be assumed that it will remain unchanged for the time that the company holds the rights in fact. In other words, as for the notional royalty, the marketing assets royalty is deemed to have an even profile over its life;
- note however that the royalty needs to be reassessed for each accounting period, using the same assumptions. In practice it is expected that the percentage royalty might well stay the same for several years; and
- the company must value the royalty on the assets in accordance with OECD article 9 and model tax convention, and the OECD transfer pricing guidelines.

357CM – Actual Marketing Royalty

3.98 The actual marketing royalty is to be subtracted from the notional marketing royalty to give the deduction from QRP. This is so that the marketing assets return is limited to profits which accrue to the company. The actual marketing royalty is the part of the return to marketing assets which accrues to third parties.

3.99 It is defined as a proportion of the aggregate amounts paid in the accounting period and brought into account as debits in the corporation tax computation for the relevant marketing assets. This amount could be a royalty paid to use a marketing asset or an amortisation charge in relation to an acquired marketing asset.

3.100 The proportion is X%, where this is the percentage given by step 2 in the calculation of QRP. In other words this is the ratio of RIPI to total gross income, as a percentage. Where a streaming election has been made, this provision is modified by 357DA(7), which substitutes for X% the amount of such debits that have been allocated to the RIPI stream.

357CN - Profits arising before grant of right

3.101 There may be a number of years between application for a patent and grant. This is usually known as the patent pending period.

3.102 The legislation allows a company to claim additional relief in the accounting period in which a patent is granted in order to recognise any qualifying income and profits from exploiting the patented invention after application for the patent, for up to six years prior to the grant of the patent.

3.103 A company is entitled to elect to add an additional amount to its relevant IP profits in any accounting period in which a patent is granted to it or in which a patent to which it holds an exclusive licence is granted.

3.104 A company is also entitled to make such an election if it received income while the patent is pending, but disposes of its rights before the patent is granted.

3.105 The additional amount is the difference between:

- the aggregate of the relevant IP profits of the trade for each accounting period for which the patent application was pending and which ended no more than 6 years prior to the grant; and
- what the aggregate of the relevant IP profits of the trade would have been, for those accounting periods, if the patent had been granted at the date of application (or 6 years before the date of grant if later).

3.106 Any profits that are or would not be taken into account in the Patent Box because they are off-set by a relevant IP loss amount are disregarded in this computation.

3.107 Additionally any accounting periods where the company was not elected into the regime or was not a qualifying company are disregarded.

3.108 However where a company would have been a qualifying company for an accounting period but for the fact that the patent in question had not been granted, it is to be treated as a qualifying company for the purposes of this section.

3.109 So a company will need to have stated when completing its corporation tax returns for these earlier periods that it would have elected into the patent box had the patent been granted at that time. It may be sensible also to calculate at that earlier time what the RIPP would have been.

3.110 Similarly where a company would have been a qualifying company for the accounting period in which the patent was granted but for the fact that it disposed of the patent, or exclusive licence over the patent, before the date of grant, it is to be treated as qualifying for the purposes of this section.

3.111 If a relevant patent pending period produces a negative figure for RIPP (known as a "relevant IP loss" (RIPL) – see Chapter 5 below), then if a company has elected to include this patent pending period in its Patent Box calculation this RIPL must be deducted in calculating the aggregate profit figure.

Chapter 4 – Streaming

4.1 In some instances apportioning the profits of a trade by using a simple ratio of RIPI to total gross income will not give an acceptable estimate of the company's actual profits from exploitation of its qualifying IP rights.

4.2 This may occur to a company's disadvantage in circumstances where it has a significant amount of non-IP income that produces relatively little profit and a smaller proportion of income that is relevant IP income but produces a much larger level of profit. For example:

- A company which manufactures and sells a range of established products, none of which incorporate items protected by qualifying IP. Turnover from this activity is £900,000 but its net profits are only £50,000. The company also owns qualifying IP which it developed many years previously and has licensed out to another business which takes care of manufacturing, marketing, distribution and sales. It receives an annual licence fee of £100,000.
- If the trade profits of £150,000 are apportioned by the ratio of RIPI to total gross income the result will be: £100,000/£1,000,000 x £150,000 = £15,000
- But clearly in this example the company will want profits of £100,000 to qualify for the Patent Box.

4.3 There may also be converse situations where a company manufactures and sells items which rely on qualifying IP rights and also receives licence royalties in respect of non-qualifying IP:

- A company's receipts from exploiting qualifying IP rights is £1 million on which it generates a profit of £200,000. Its licence income is £1million all of which is profit.
- If the trade profits of £1,200,000 are apportioned by the ratio of RIPI to total income the result will be: £1,000,000/£2,000,000 x £1,200,000 = £600,000
- So £400,000 of profit from non-qualifying IP will potentially qualify as RIPP.

357D – Alternative method of calculating relevant IP profits: "streaming"

4.4 The June 2011 Consultation Document recognised these potentially anomalous results from the normal formulaic way of apportioning profits. The proposed approach to deal with them was "divisionalisation": where the company's trade could be split into notional divisions that transacted at arms length with each other.

4.5 Following consultation, the draft legislation takes a slightly different and more straightforward course. This is to allocate expenses and profits to particular income streams on a just and reasonable basis.

4.6 This approach can be applied if the company elects to do so. This is known as a streaming election.

4.7 The draft legislation specifies also that the alternative streaming basis **must** be used in certain situations: where 'the mandatory streaming condition' set out in 357DC is met.

4.8 Where a company makes a streaming election the election applies for each of that company's trades and all subsequent accounting periods (subject to an exception provided for in 357DB – see below).

357DA – Relevant IP profits

4.9 This alternative basis works by replacing steps 1 to 4 of 357C with three alternative steps as follows:

Streaming step 1

4.10 The total gross income of the trade is divided into two 'streams' of income, by identifying how much of that total gross income is relevant IP income (this will include any notional royalty allowed by 357CC) and how much is not relevant IP income.

Streaming step 2

4.11 The debits deducted from total gross income in arriving at taxable trading profit (excluding any additional deduction under Part 13 of CTA 2009 for R&D expenditure and any deduction for trading loan relationship debits) are then allocated against the stream to which they relate on a just and reasonable basis.

4.12 The aim is that debits that arise in generating the relevant IP income are allocated against the relevant IP income stream and debits that arise in generating the non relevant IP income stream are allocated against the non-relevant IP income stream.

4.13 Clearly, what is just and reasonable will depend on the specific circumstances. However all expenses must be allocated, and so for instance R&D (but not the additional Part 13 deduction), which may of course relate to future income, must still be fairly allocated to the current income streams.

Streaming step 3

4.14 This requires the company to deduct the debits allocated against the relevant IP income stream from that income stream to give a figure to carry forward to step 4.

Streaming step 4

4.15 The company must now apply the 10% routine return percentage to any routine expenses included in the debits allocated against the relevant IP income stream (other than R&D expenses) and deduct the resulting figure from the figure produced by step 3 to give the figure of QRP.

4.16 Steps 5 and 6 follow the same approach as the same as for the normal calculation in 357C, other than in Step 6 where it is the aggregate of any actual marketing royalty allocated to the relevant IP stream that is deducted from the notional royalty in calculating what should be deducted from QRP.

357DB – Method of allocation

4.17 357DA also makes clear that to be just and reasonable, normally a method of allocation must be consistent between one year and the next, unless there is a change of circumstances that make the method inappropriate.

4.18 In this case, the company can choose to use a different method that does produce a just and reasonable result, or to exit from streaming and use the simple apportionment formula.

4.19 If the company chooses to use the simple apportionment formula it can however make a fresh streaming election for any subsequent accounting periods if it wishes to do so. However, once it re-elects to stream then it must apply this consistently year on year unless there is a change of circumstances.

4.20 An example to illustrate streaming is below:

A company develops, manufactures and sells a range of branded patented products in the UK. It also licenses out the right to manufacture the products in other countries using its patented technology, know-how, and brand. In addition, the company uses its excess manufacturing capability to provide manufacturing services on a contract basis to other group companies.

- The company allocates its cost of goods on a direct basis
- The company determines that other manufacturing costs are incurred equally whether patented or non-patented goods are being manufactured. It therefore determines that these costs should be allocated based on the number of units produced.
- The company allocates all its R&D department costs to the RIPI stream. NB: It does not matter how these costs are allocated to manufacturing and licensing within this stream, as both produce fully qualifying income
- All "other manufacturing costs" are "routine expenses", while none of the cost of goods are. R&D costs are outsourced.

The company's streamed P&L may look like this:

		RIPI		Non-RIPI
	Total	Full-risk Manufacturing	Licensing	Contract Manufacturing
Income	10,000	6,000	1,000	3,000
Cost of Goods	4,000	2,000	-	2,000
Gross Profit	6,000	4,000	1,000	1000
Other Manufacturing costs	1,400	700	-	700
Profit before R&D costs	4,600	3,300	1,000	300
R&D Costs	2,600	2,600		
PCTCT	2,000	1,700		300

Streaming Calculation
Step 1: RIPI is calculated as £7000
Step 2: Total debits of £4,300 are allocated against RIPI (£2,000 + £700 + £2,600)
Step 3: Deduct debits from RIPI leaving stream profits of £1,700
Step 4: Apply routine return of 10% to routine expenses of £700 included in RIPI stream. Deduct this £70 from the £1,700 to give QRP of £1,640
Step 5: The company elects for small claims treatment, so its RIPP is 75% of QRP, or £1,230
The company's Patent Box tax deduction is therefore £1,230 x (23-10)/23 = £695
The company's corporation tax profit is therefore reduced to £1,305; and its corporation tax payable is reduced from £460 to £300

357DC – The mandatory streaming condition

4.21 The mandatory streaming condition is met where the total gross income of the trade includes not only relevant IP income but also a substantial amount of licensing income that is not relevant IP income.

4.22 Licensing income means generally any licence fee, royalty or other payment received in respect of intellectual property of the company which is not a qualifying IP right.

4.23 “Substantial” in this context means the lower of £2 million or 20% of the total gross income of the trade for the accounting period.

4.24 However, if the lower of these two amounts is £50,000 or less then the mandatory streaming condition is not met.

Chapter 5 – Companies with relevant IP losses

357E to 357EE

5.1 Particularly in the early stages of IP development a company may derive income from its qualifying IP rights but not yet return a profit. Or it may produce a profit but this is less than a routine return on the costs of earning the income. In this case the calculation of relevant IP profits will result in a negative figure, referred to in the legislation as a relevant IP loss.

5.2 One consequence for the company is that there is no amount of RIPP. As a result the company will be taxed on its actual profits, or will be able to relieve its losses, as if it had made no election into the Patent Box.

357E – Company with relevant IP losses: set-off amount

5.3 Where a company has a relevant IP loss then the 357E sets out that a company has a set-off amount which is equivalent to this loss.

357EA – Set-off against RIPP of other trades carried on by the company

5.4 Where a company has a set-off amount and, unusually, the company has another Patent Box trade with RIPP, then the set-off amount must be reduced by the RIPP of that other trade.

5.5 The RIPP that has been used to reduce the set-off amount is then not included in the amount of RIPP that is used to calculate the Patent Box deduction in 357A(3).

357EB – Set-off against other group companies' RIPP

5.6 If, after the reduction of the set-off amount under section 357EA, there is still a set-off amount remaining, then the excess reduced by any RIPP of other relevant group companies for the relevant accounting period.

5.7 An accounting period of a company that has a set-off amount is a relevant accounting period if it ends at the same time as or within an accounting period of another group member . The other group member is a relevant group member if it has made an election under section 357A that has effect in relation to that period.

5.8 Again any RIPP used to reduce the set-off amount is no longer eligible to be included in calculating its Patent Box deduction for that accounting period.

5.9 Where there is more than one company within the group with RIPP which are subject to set-off the group may determine in which order the set-off is to be made. If no determination is made the set-off amount will reduced by the company with the greatest amount of RIPP first, then the next largest and so on.

357EC – Carry Forward of Set-Off Amount

5.10 If, after the application of section 357EA and 357EB, the company has remaining set-off amounts, it carry these forward against any RIPP arising in the following accounting period.

5.11 If the set-off carried forward exceeds the RIPP of the company and the company is a member of a group the balance of the set-off should be reduced by RIPP of other group members applying the rules described in section 357EB above. Again, any RIPP which is used to reduce the carried forward set-off amount is no longer eligible for the Patent Box deduction.

5.12 Any set-off amounts which still remain unreduced are carried forward and reduced by RIPP of future accounting periods as described above.

357ED – Company Ceasing to Trade etc

5.13 If a company ceases to trade, ceases to be within the charge to corporation tax in respect of the trade or the Patent Box election ceases to have effect, then any unreduced set-off amounts are transferred to any other group member that is a qualifying company at the relevant time.

5.14 The group can decide which group members with RIPP are to be allocated the set-off amount. If there are no companies with RIPP then the sum goes to the company with the largest set-off amount of its own.

5.15 If there are no companies elected into the patent box or which are qualifying companies, then the set-off amount is reduced to nil.

357EE – Transfer of trade intra-group

5.16 The set-off amount goes to the transferee if in an accounting period the trade is transferred to another group company.

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Chapter 6 – Anti –avoidance

357F to FB – Tax advantage schemes

6.1 This chapter contains anti-avoidance rules covering the regime.

6.2 The first rule, in 357F, is intended to prevent commercial irrelevant exclusivity being conferred under a licence in order primarily to ensure that income generated by the licensee qualifies for the Patent Box. It is not intended to apply if there is a commercially reasonable choice about exclusivity, and the two parties agree to opt for one because the licensee recognises that it will then qualify for the patent box.

6.3 The second rule, in 357FA, is aimed at cases where a patented item is incorporated into a product for a main purpose of securing that income arising from sale of the product is relevant IP income. Again, it is intended to apply where a choice is made for tax purposes when there is no, or insignificant, commercial rationale. It is not intended to affect any reasonable commercial choice.

6.4 The main anti-avoidance rule is section 357FB. It applies where a company which is entitled to make a deduction under 357A is party to a scheme and one of the main purposes of the scheme is to obtain a relevant tax advantage.

6.5 A relevant tax advantage arise where:

- relevant IP profits are increased as a result of the scheme; and
- the scheme is of a specified type

6.6 Specified types of schemes are:

- schemes designed to avoid the application of any provision in Part 8A;
- schemes designed to create a mismatch between the expense of acquiring or developing a qualifying IP right (or exclusive licence over a qualifying IP right) and the income arising from that right or licence. Such a mismatch would occur if the expense is incurred whilst the company (or a company with which it is grouped) is outside the regime, whilst the income arises once the company has elected in to the regime; and
- schemes designed so that income that the company brings into account in computing its trading profits is not recognised as revenue but as some other item in the company’s income statement or profit and loss account. Such schemes could be used to skew the proportion of profits qualifying for the patent box if for instance non patent-derived income was recognised other than in total gross income.

Chapter 7 – Supplementary

357G – Making of an election under section 357A

7.1 To elect in to the regime under 357A a company must give notice in writing. The notice must specify the first accounting period for which the election will apply.

7.2 The latest time for providing notice of an election is the last day on which the company would be entitled to amend its tax return, under paragraph 15 of Schedule 18 of FA 1998, for the first accounting period to which it is intended to apply.

7.3 In practice this means within 12 months of the fixed filing date of the return for the first accounting period for which the company wishes to elect in to the regime.

7.4 An election will apply equally to all trades of the company and for all subsequent accounting periods until it is revoked.

357GA – Revocation of election made under section 357A

7.5 A company must continue to calculate the relevant IP profits of each its trades for each accounting period following an election into the regime, until that election is revoked by giving notice in writing. The notice must specify the first accounting period for which the revocation is to have effect.

7.6 The latest time for revoking an election is the last day on which the company would be entitled to amend its tax return, under paragraph 15 of Schedule 18 of FA 1998, for the first accounting period to which it is intended to apply.

7.7 As with an election into the Patent Box, in practice this means within 12 months of the fixed filing date of the return for the first accounting period for which the company wishes to elect in to the regime.

7.8 The revocation will apply equally to all trades of the company and for all subsequent accounting periods until a new valid election is made.

7.9 Once an election has been revoked, a fresh election under 357A will have no effect for any accounting period which begins less than 5 years after the last day of the accounting period specified in the revocation notice.

7.10 This is to ensure that companies do not dip in and out of the regime for purposes which would amount to an abuse of the regime, for example to exclude periods when a company would be required to register a set-off amount that would affect the relief available to other group companies.

357GB – Application to partnerships

7.11 357A makes it clear that only a company may elect in to the regime. However a qualifying IP right may sometimes be developed on a collaborative basis using partnership arrangements. Where one of the partners is a company section 1259 CTA 2009 will be relevant. This requires trade profits to be computed as if the partnership were a company and each corporate to be allocated an amount of these profits based on its profit share.

7.12 The legislation provides a mechanism for a corporate partner in a partnership that meets both the development and active ownership requirements in respect of qualifying IP rights it holds to obtain the benefits of the Patent Box.

7.13 This is achieved by allowing the partners to elect to be taxed as if the partnership itself had elected into the regime. As a result of such an election the profit allocated to the partner will be reduced through the Patent Box calculation such that the effect will be that the actual profits are charged at 10%.

7.14 The election is made on a company-by-company basis. So some partners may elect in and some may not.

7.15 A partnership meets the development condition in relation to a qualifying IP right for the purposes of this section if it has itself carried out qualifying development in relation to the right, or if a ‘relevant corporate partner’ (entitled to at least a 40% share of profits or losses) has done so.

357GC – Application of this Part in relation to cost sharing arrangements

7.16 Cost sharing arrangements (CSA) are a normal commercial arrangement allowing businesses to share the costs and risks of developing, producing or obtaining assets, services, or rights. The participants will contribute to the activities in proportion to the benefits each expects to obtain.

7.17 A CSA may establish a separate legal entity or simply amount to contractual arrangements. Where the CSA is a company or partnership then the Patent Box calculation will be applied to the entity. But where there is no such entity then section 357GC will be relevant.

7.18 CSAs are often entered into where R&D and/or funding for R&D is split between 2 or more companies. The reason for this may be that each of the participator companies has a specialist area of research or because one or more of the participators have R&D expertise and/or facilities but no capital to fund it and the other or others have capital but no R&D expertise or facilities.

7.19 The basic idea is that R&D is carried out by those participators best placed to carry it out, but the costs arising are borne by all of the participators in previously agreed proportions.

7.20 For example, 3 companies may have R&D facilities which allow them to carry on complementary R&D in different fields of research with a view to combining the results into one specific product. There is no guarantee that the costs of each specialist area of research will equalise, so the participators might agree that the income arising from any resultant IP (including, but not exclusive to, patents) will be split according to the relative costs incurred by each participator. Alternatively they may agree that the costs incurred by each participator should be recorded and that the greatest contributor will be reimbursed a proportion of their costs by the other participators. The income arising from the resultant IP would then be split equally between the participators.

7.21 Accordingly, each of the participators will have contributed to the development of the IP and will be entitled to a share of the income from that IP as a result. To the extent that this income includes income from a qualifying patent it should qualify for the Patent Box.

7.22 However, participators will not necessarily own the qualifying patent nor be an exclusive licensee since their entitlement flows from the CSA itself.

7.23 Section 357GC applies where one of the parties to the arrangement holds a qualifying IP right or exclusive licence and each of those parities is required to contribute to the development of the item to which the right relates or any product incorporating it. Provided that each party to the arrangement is entitled to a share of the income from exploiting the right then it is treated as if it held the relevant right itself.

7.24 The company will therefore be entitled to claim the benefits of the regime in relation to that right subject to the normal rules of Part 8A.

7.25 357GC is however specifically disapplied if the income that arises to the company from the arrangement is economically equivalent to interest. This is in keeping with the requirement that companies are actively involved in the development or management of qualifying IP rights and are not just passive investors, and that only profits attributable to the risks and rewards of such activity benefit from the Patent Box.

357GD – Meaning of Group

7.26 The definition of group for the purposes of the regime is widely drawn so that it will allow joint venture entities and smaller groups that might not be required to be fully consolidated in group accounts under section 399 of the 2006 Companies Act to fall within the definition.

7.27 The definition is relevant for the purposes of the development condition, the active ownership condition routine expenses, tax advantage schemes and the procedure for dealing with set-off amounts.

Chapter 8 – Amendments of other legislation

Interaction with other Legislation

Transfer pricing

7.28 In the context of the Patent Box there is a risk of UK taxpayers shifting profits from one entity (the advantaged person) to another entity (the disadvantaged person) who is a Patent Box claimant.

7.29 However there is an exemption from transfer pricing rules for the vast majority of transactions carried out by businesses that are EU small or medium enterprises. There are some exceptions to this set out in TIOPA sections 167 and 168. Section 168 TIOPA can require a medium sized enterprise to use arms length principles on receipt of a notice from HMRC.

7.30 The draft legislation includes a provision to amend section167. This will insert another exception to the small enterprises exemption. This will allow HMRC to issue transfer pricing notices to reapply TIOPA Part 4 to provisions of a small enterprise where at least one provision involves a transaction taken into account in an affected person's calculation of Patent Box profits.

Double taxation relief

7.31 Under sections 44-48 TIOPA 2010 double taxation relief (DTR) is allowed for withholding tax (WHT) on patent royalties up to the amount of corporation tax payable on the transaction, arrangement or asset in respect of which the royalties are paid.

7.32 The Patent Box deduction will be bought into the DTR calculation and by reducing the CT chargeable may result in a restriction of the DTR available.

7.33 A simple example of a DTR calculation including the Patent Box is given below:

A company has royalty income of £1000 from licensing one of its patents.

£400 of this comes from overseas territories, on which the company has suffered a total of £30 of overseas WHT.

The company incurs costs of £400 to generate its royalties, incurred equally for all royalties. It elects into the Patent Box and calculates its Patent Box tax deduction as £300.

The company's DTR calculation under section 44 would look like this:

Royalty	£400
Share of costs	£160
Share of Patent Box tax deduction	£120
Corporation tax profit	£120
CT @ 23%	£28
WHT Suffered	£30

The company's DTR is therefore limited to £28 and the CT computation will look like this:

Royalties	£1000
Costs	£400
Patent Box tax deduction	£300
Corporation tax profit	£300
CT @ 23%	£69
DTR	£28
CT payable	£41

Chapter 9 – Commencement and Transitional Provision

Application

9.1 The regime has effect in relation to income and gains from 1 April 2013.

9.2 Where an accounting period straddles that date income or gains arising in that period are to be apportioned between the period prior to 1 April 2013 and the period from 1 April 2013 on a just and reasonable basis.

Special treatment of profits to be phased in

9.3 The full benefit of the regime will be phased in over the first four financial years following commencement on 1 April 2013.

9.4 This will be done by applying an appropriate percentage by financial year to the relevant IP profits of the company for each accounting period.

9.5 The appropriate percentages for each financial year are:

Year	2013	2014	2015	2016
Percentage	60%	70%	80%	90%

9.6 Where an accounting period falls within more than one financial year the relevant IP profits of the company for that accounting period should be apportioned to each financial year.

9.7 For example for a company with relevant IP profits of £100,000 for an accounting period of 1 January 2014 to 31 December 2014, the effect will be:

Relevant IP profits of the period	£100,000
Profits falling in FY 2013 90/365 x £100,000	£24,658
Profits falling in FY 2014 275/365 x £100,000	£75,342
FY2013 60% x £24,658 FY2014 70% x £75,342	£14,795 £52,740
Adjusted Relevant IP profits of period	£67,534

Part 2 para 8 - Companies with relevant IP losses: interaction with phasing in of benefits

9.8 To match the phasing in of the lower rate on profits, set-off amounts between 2013 and 2016 which are carried forward are reduced according to a formula. This reflects the fact that the Patent Box benefits increase each year by 10%, from the initial figure of 60%.

9.9 The formula is : 10% /P where P is the percentage applied in the following year to the Patent Box RIPP before substituting into the formula deduction.

The Patent Box Legislation: an outline Guide

Does the company want to be in the Patent Box?	Chapter 1 **357A** specifies:	• Election for a lower rate • Delivery by a profits deduction based on relevant IP profits (RIPP) • The formula to calculate the deduction
Does the company qualify to be in the Patent Box?	Chapter 2 **357B to 357BD** specifies:	• The types of IP right that the company can own • Inclusion, and definition, of exclusive licences • The development condition for these rights • The active ownership condition for group companies
How are the relevant IP profits calculated?	Chapter 3 **357C to 357CA** specifies: **Main calculation approach**	• Apportionment of profits according to the proportion of "total income" that is relevant IP income (RIPI) • Elimination of routine profit by mark up of certain costs, to give "qualifying residual profit" (QRP) • If the company elects for small claims treatment, calculation of RIPP as a proportion of QRP • Otherwise, the calculation of RIPP by removal from QRP of a return on marketing assets
	Chapter 3 **357CB to 357CE** specifies: **RIPI**	• What income (and from what sources & items) can be RIPI • What other income can be deemed to be RIPI by way of a notional patent royalty • What income cannot be RIPI • Identification of RIPI arising from mixed agreements
	Chapter 3 **357CF to 357CG** specifies: **adjustments to profits**	• Profits apportioned according to RIPI are before R&D tax credits and net finance expenses • Profits apportioned may be reduced by additional notional R&D expenditure in the first 4 years after electing into the Patent Box if R&D expenditure is significantly reduced from levels before then
	Chapter 3 **357CH to 357CI**specifies:	• Routine profit is to be excluded from the Patent Box by assuming particular expenses generate a 10% return. This return is to be deducted in computing QRP
	Chapter 3 **357CJ to 357CM** specifies: **Small claims & brand exclusion**	• If a company elects for small claims treatment the relevant IP profits are 75% of QRP, up to a maximum of £1m • Otherwise, RIPP are calculated by removing a return equivalent to a notional royalty for relevant marketing assets, less any actual marketing royalty paid in relation to these assets
What happens to income while the patent is pending?	Chapter 3 **357CN** specifies: **Pat. pending income**	• Profits earned while a patent is pending, up to a maximum of 6 years before grant, can be treated as RIPP in the accounting period of the grant, if they would have been RIPP had the patent been granted at the time the profits were earned
What if the pro-rata apportionment of profit to RIPI is inappropriate?	Chapter 4 **357D to 357DC** specifies: **Alternative calculation**	• On election, a company can allocate expenses to RIPI and non-RIPI streams on a just and reasonable basis • A company must do this for substantial licensing income • The calculation then proceeds as above, but using these expenses and the profit identified using them
How are elections made, what happens for partnerships etc and how are matters defined in the legislation?	Chapters 5, 6 and 7 **357E to 357GE** specify:	• Negative RIPP amounts must offset other Patent Box profits • Anti-avoidance rules • Mechanics of electing into the Patent Box and revocation (including a subsequent 5 year exclusion) • Rules for partnerships and cost sharing arrangements • Definitions of "group" and "protected item" and certain other terms used in the legislation

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Professor Foley's research focuses on international corporate finance with a particular emphasis on the activities of multinational firms. He has investigated the use of international joint ventures, the determinants of multinational affiliate capital structure and dividend repatriations, the advantages associated with internal capital and labor markets, the impact of capital controls on multinationals, and the effects of stock market valuations on foreign direct investment. His work on how intellectual property rights influence international technological transfers has been funded by grants from the National Science Foundation, the World Bank, and the Asian Development Bank. His academic articles have appeared in several journals including *The Journal of Finance*, the *Journal of Financial Economics*, the *Journal of Public Economics*, the *National Tax Journal*, the *Review of Financial Studies*, and the *Quarterly Journal of Economics*.

Prior to joining HBS, Professor Foley taught at the University of Michigan Business School. He received a Ph. D. in Business Economics from Harvard University and a B.A. in Ethics, Politics, and Economics from Yale University. Professor Foley has also worked as a strategy consultant at Monitor Company and conducted research on multinational firms in the apparel export sector as a Fulbright Scholar in Sri Lanka.

Ken Gao

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Ken is member of PwC China Desk in New York.

Ken has extensive experience in advising corporate investors into China, in particular, advising on holding and financing structures, investment vehicles, tax efficient business models and cash expatriation strategies.

Ken has over 6 years experience as a tax practitioner with PricewaterhouseCooper in China and has worked with companies with a wide range of industries including telecommuniction, pharmacuetic, real estate, retail and distribution, etc

Ken is member of the Association of Chartered Certified Accounts (ACCA).

Michael J. Graetz

Michael J. Graetz is the Isidor and Seville Sulzbacher Professor of Law and the Columbia Alumni Professor of Tax Law at Columbia Law School. Before coming to Columbia in 2009, he was the Justus S. Hotchkiss Professor of Law at Yale University, where he had taught since 1983. Before Yale, he was a professor of law at the University of Virginia and the University of Southern California law schools and Professor of Law and Social Sciences at the California Institute of Technology. His publications on the subject of Federal taxation include a leading law school text and more than 60 articles on a wide range of tax, international taxation, health policy, and social insurance issues in books and scholarly journals. His most recent book is *100 Million Unnecessary Returns: A Simple, Fair, and Competitive Tax Plan for the United States,* published by Yale University Press, in 2008. His previous books include *Death by a Thousand Cuts: The Fight over Taxing Inherited Wealth* (Princeton University Press; 2005); *True Security: Rethinking Social Insurance* (Yale University Press, 1999); and *The U.S. Income Tax: What It Is, How It Got That Way and Where We go From Here*, (W.W. Norton & Co, 1999) (a paperback edition of the book originally published as *The Decline (and Fall?) of the Income Tax*) and *Foundations of International Income Taxation* (Foundation Press, 2003.) He is also the co-author of a leading law school coursebook, *Federal Income Taxation: Principles and Policies,* (Foundation Press; 2009).

During January-June 1992, Michael Graetz served as Assistant to the Secretary and Special Counsel at the Treasury Department. In 1990 and 1991, he served as Treasury Deputy Assistant Secretary for Tax Policy. Professor Graetz has been a John Simon Guggenheim Memorial Fellow, and he received an award from Esquire Magazine for courses and work in connection with provision of shelter for the homeless. He served on the Commissioner's Advisory Group of the Internal Revenue Service. He served previously in the Treasury Department in the Office of Tax Legislative Counsel during 1969-1972. He is a fellow of the American Academy of Arts and Sciences.

Professor Graetz is a graduate of Emory University (B.B.A. 1966) and the University of Virginia Law School (J.D. 1969). A native of Atlanta, Georgia, Michael Graetz is married to Brett Dignam and has five children.

Rachel Griffith

Professor Rachel Griffith is a Deputy Research Director at IFS, Professor of Economics at the University of Manchester, a Fellow of the British Academy, Editor of the Economic Journal and a Research Fellow of CEPR. Her research considers the relationship between government policy and economic performance. Her specific interests relate to the food industry, innovation and productivity.

Kevin A. Hassett

Kevin is the director of economic policy studies and a senior fellow at AEI. Before joining AEI, he was a senior economist at the Board of Governors of the Federal Reserve System and an associate professor of economics and finance at the Graduate School of Business of Columbia University, as well as a policy consultant to the Treasury Department during the George H. W. Bush and Clinton administrations. He served as an economic adviser to the George W. Bush 2004 presidential campaign, chief economic adviser to Senator John McCain during the 2000 presidential primaries, and senior economic adviser to the McCain 2008 presidential campaign. Mr. Hassett also writes a column for *National Review*.

James R. Hines Jr.

James Hines teaches at the University of Michigan, where he is the Richard A. Musgrave Collegiate Professor of Economics in the department of economics and the L. Hart Wright Collegiate Professor of Law in the law school. He also serves as Research Director of the Office of Tax Policy Research at the Ross School of Business. His research concerns various aspects of taxation. He holds a B.A. and M.A. from Yale University and a Ph.D. from Harvard, all in economics. He was on the faculties of Princeton and Harvard prior to moving to Michigan, and has held visiting appointments at Columbia University, the London School of Economics, the University of California-Berkeley, and Harvard Law School. He is a research associate of the National Bureau of Economic Research, research director of the International Tax Policy Forum, co-editor of the American Economic Association's *Journal of Economic Perspectives*, and once, long ago, was an economist in the United States Department of Commerce.

Helen Miller

Helen Miller is a senior research economist at the Institute for Fiscal Studies. Her research considers the relationships between government policy and firm behaviour. Her specific interests relate to the location of firms' activities, corporate taxes and government tax competition.

Paul W. Oosterhuis

Paul W. Oosterhuis, coordinator of Skadden, Arps's international tax practice, represents clients on a wide range of international and domestic tax matters.

He has extensive experience in international mergers and acquisitions, post-acquisition integration transactions, spin-off transactions, internal restructurings and joint venture transactions. Mr. Oosterhuis also represents U.S. and non-U.S. multinational companies in non-transactional international tax planning and IRS controversy matters.

In international acquisitions, Mr. Oosterhuis has represented:

- Alcatel S.A. in its pending acquisition of Lucent Technologies;
- Quicksilver in its acquisition of Rossignol SA;
- Yahoo! Inc. in the combination of its Chinese business with Alibaba.com Corporation;
- Royal Dutch NV and Shell Transport Ltd. in their restructuring to form Royal Dutch Shell plc;
- IBM Corporation in its acquisition of the PwC consulting firms around the world; and
- Daimler-Benz in its combination with Chrysler Corporation.

He has also represented numerous clients in internal restructuring and post-acquisition integration efforts, including: Hewlett-Packard Company; Pfizer Inc., GlaxoSmithKline; Exxon Mobil and Daimler Chrysler.

With respect to the international aspects of public spin-off transactions, he has represented various clients, including Hewlett-Packard, Baxter International, DuPont, 3M and Cooper Industries.

Apart from specific transactions, Mr. Oosterhuis regularly represents clients on international tax planning matters generally, including transfer pricing matters. He also represents clients in audits and appeals before the Internal Revenue Service and has negotiated on behalf of clients various advance pricing agreements, pre-filing agreements, and competent authority agreements. Representative clients on these matters include: The Bank of New York, Dell, Inc., GlaxoSmithKline, Hewlett-Packard Company, Intel Corporation, International Paper, NTL, Royal Dutch Shell, Schering-Plough Corporation and Transocean. He also serves as outside tax counsel for the Pharmaceutical Research Manufacturers Association.

He has regularly been selected for inclusion in *Chambers USA*, including in *America's Leading Lawyers for Business 2006*, and has been consistently rated one of the top tax lawyers in Washington, D.C. by the Chambers Global Survey, including in *The World's Leading Lawyers 2004-2005*.

Nirupama Rao

Nirupama Rao is an Assistant Professor of Economics and Public Policy at NYU's Wagner School of Public Service. She studies public economics and focuses on the impact of policy on production, investment and pricing decisions. Her dissertation investigates the impact of tax policy on firm behavior. The main chapter investigates how excise taxes on oil production affect the extraction decisions of domestic producers. Other chapters assess the effectiveness of R&D tax credits and investigate the composition and importance of corporate deferred taxes. She has also been working on projects relating to the monopoly power conferred by state liquor regulation and is a researcher at the Center for Robust Decision Making on Climate and Energy Policy at the University of Chicago. She completed her PhD in economics at MIT in June 2010 where she previously earned her undergraduate degree.

John M. Samuels

John Samuels is GE's Vice President and Senior Counsel for Tax Policy and Planning. He is responsible for GE's worldwide Tax Organization and for the Company's global tax planning and tax compliance operations. He is a member of GE's Corporate Executive Council, the GE Capital Corporation Board of Directors, the GE Finance Council and the GE Pension Board.

Prior to joining GE in 1988, he was a partner in the law firm of Dewey, Ballantine in Washington, D.C. and New York City. From 1976 to 1981 Mr. Samuels served as the Deputy Tax Legislative Counsel and Tax Legislative Counsel of the U.S. Department of Treasury in Washington, D.C.

Mr. Samuels is the Chairman of the International Tax Policy Forum, a Fellow of the American College of Tax Counsel, and a member of the University of Chicago Law School Visiting Committee. Mr. Samuels was an adjunct professor of taxation of NYU Law School (1975 to 1986), and currently is the Jacquin D. Bierman Visiting Lecturer at Yale Law School where he teaches courses in international taxation.

Mr. Samuels is a graduate of Vanderbilt University (1966) and the University of Chicago Law School (1969), and received an LLM in taxation (1976) from NYU Law School.

James Shanahan

Mr. James R. (Jim) Shanahan, Jr., an attorney and CPA, is a partner in the Washington National Tax Services office of PricewaterhouseCoopers LLP in Washington, DC. Jim specializes in tax issues arising in complex intellectual property transactions including, tax planning, transfer pricing and controversies with the IRS. He has broad experience in federal tax matters, including the special tax incentives afforded U.S. R&D and commercialization activities. Jim brings 30 years experience monitoring and analyzing federal tax legislation and regulatory matters for a wide spectrum of clients - with a focus on technology companies.

Jim has extensive experience with the tax legislative/regulatory process and its policy implications. Jim joined Price Waterhouse LLP in 1975 after graduating from the University of Notre Dame. In 1982, after receiving his J.D. from the Southwestern Law School, he transferred from the Los Angeles office to the firm's national office in Washington, D.C. Jim is a member of the American Bar Association and the American Institute of Certified Public Accountants.

Stephen E. Shay

Stephen E. Shay is a Professor of Practice at Harvard Law School. Before joining the Harvard Law School faculty, Professor Shay was Deputy Assistant Secretary for International Tax Affairs in the United States Department of the Treasury and prior to re-joining the Treasury Department in 2009, he was a tax partner for 22 years with Ropes & Gray, LLP. Professor Shay served in the Office of International Tax Counsel at the Department of the Treasury, including as International Tax Counsel, from 1982 to 1987. Professor Shay has published scholarly and practice articles relating to international taxation, and testified for law reform before Congressional tax-writing committees. He has had extensive practice experience in the international tax area and has been recognized as a leading practitioner in Chambers Global: The World's Leading Lawyers, Chambers USA: America's Leading Lawyers, The Best Lawyers in America, Euromoney's Guide to The World's Leading Tax Advisers and Euromoney's, Guide to The Best of the Best. Professor Shay has been active in the American Bar Association Tax Section as a Council Director and Chair of the Committee on Foreign Activities of U.S. Taxpayers, in the American Law Institute as an Associate Reporter, in the American Tax Policy Institute as a member of the Board of Trustees, and in the New York State Bar Association Tax Section and the International Bar Association. Professor Shay is a 1972 graduate of Wesleyan University, and he earned his J.D. and his M.B.A. from Columbia University in 1976.

Matthew J. Slaughter
Associate Dean of the MBA Program
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Matthew J. Slaughter is the Associate Dean of the MBA Program and the Signal Companies Professor of Management at the Tuck School of Business at Dartmouth. He is also currently a Research Associate at the National Bureau of Economic Research; a Senior Fellow at the Council on Foreign Relations; an academic advisor to the McKinsey Global Institute; and a member of the academic advisory board of the International Tax Policy Forum.

From 2005 to 2007, Professor Slaughter served as a Member on the Council of Economic Advisers in the Executive Office of the President. In this Senate-confirmed position he held the international portfolio, advising the President, the Cabinet, and many others on issues including international trade and investment, currency and energy markets, and the competitiveness of the U.S. economy. He has also been affiliated with the Federal Reserve Board, the International Monetary Fund, the World Bank, the National Academy of Sciences, the Institute for International Economics, and the Department of Labor.

Professor Slaughter's area of expertise is the economics and politics of globalization. His current research is examining how multinational firms can best structure their global operations; the labor-market impacts of international trade, investment, and immigration; and the political-economy questions of voter attitudes about and government policies towards globalization. This research has been supported by several grants from organizations including the National Science Foundation and the Russell Sage Foundation. Professor Slaughter has published dozens of articles as book chapters and in peer-reviewed journals; he has co-authored and co-edited three books, including *Globalization and the Perceptions of American Workers*; he has served and currently serves in various editorial positions for several academic journals; and he has made numerous presentations at academic conferences and seminars.

Professor Slaughter is a frequent keynote speaker to many audiences in the business and policy communities and he has testified before both chambers of the U.S. Congress. He regularly contributes op-eds to the *Wall Street Journal* and *Financial Times*, and his ideas are widely featured in business media such as *Business Week, The Economist, Financial Times, New York Times*, *Newsweek, Time, Wall Street Journal*, and *Washington Post*. He has appeared on several TV and radio programs such as CNN's *Lou Dobbs Tonight* and NPR's *All Things Considered*. For many years he has consulted both to individual firms and also to industry organizations that support dialogue on issues of international trade, investment, and taxation. And at Tuck he co-directs the flagship executive-education program Global Leadership 2020.

Prior to joining the Tuck faculty in 2002, since 1994 Professor Slaughter had been on the faculty of the economics department at Dartmouth, where in 2001 he received the school-wide John M. Manley Huntington Teaching Award. He received his bachelor's degree summa cum laude and Phi Beta Kappa from the University of Notre Dame in 1990, and his doctorate from the Massachusetts Institute of Technology in 1994.