THE AUSTRALIAN NATIONAL UNIVERSITY

Working Papers in Trade and Development

Tax Policy and the Globalisation of R & D

Russell Thomson

January 2009

Working Paper No. 2009/03

The Arndt-Corden Division of Economics
Research School of Pacific and Asian Studies
ANU College of Asia and the Pacific

Tax Policy and the Globalisation of R & D

Russell Thomson
The Arndt-Corden Division of Economics
Research School of Pacific and Asian Studies
College of Asia and the Pacific
The Australian National University

Corresponding Address :

Russell Thomson

As of February 2009 located at:
Melbourne Institute of Applied Economic and Social Research
University of Melbourne
Email: Russell.Thomson@unimelb.edu.au

January 2009
Working paper No. 2009/03

This Working Paper series provides a vehicle for preliminary circulation of research results in the fields of economic development and international trade. The series is intended to stimulate discussion and critical comment. Staff and visitors in any part of the Australian National University are encouraged to contribute. To facilitate prompt distribution, papers are screened, but not formally refereed.

Copies may be obtained from WWW Site
http://rspas.anu.edu.au/economics/publications.php

Tax Policy and the Globalisation of R&D

Russell Thomson

Melbourne Institute of Applied Economic and Social Research, University of Melbourne

Email: russell.thomson@unimelb.edu.au

Abstract

This paper examines the factors influencing the globalisation of R&D, with a particular focus on the role of tax policy, using panel data for 25 OECD countries over the period 1980- 2005. Two measures of R&D internationalisation are considered - R&D directly financed from abroad and R&D expenditure by foreign affiliates of US MNEs. The econometric analysis, which appropriately control for other determinants of inter-country differences in R&D investment, finds no evidence that host country R&D tax policy is an important determinant of MNE R&D location decisions or in attracting additional cross-border contract R&D. There is evidence that affiliate fixed capital stock and total sales are strong determinants of R&D performed by affiliates of US MNEs. Controlling for these variables, host country attributes seemed to be less important. In the case of cross-border contract R&D, host country expenditure on R&D via institutions of higher education is also found to be important.

JEL classification: O38, O31, O32, F21

Key words: Globalisation of R&D, tax policy, foreign direct investment, multinational enterprises

Tax Policy and the Globalisation of R&D

1. Introduction

Policies aimed at increasing national R&D activity are now a central component of national strategies to increase productivity, long run economic growth and international competitiveness in most OECD countries.[1] The rationale behind this objective rests on two assertions. First, investment in R&D is an important driver of long run productivity growth.[2] Second, without government support firms will tend to under invest in R&D relative to the social optimum.[3] To stimulate higher rates of R&D, governments employ a range of policy instruments. Incentives delivered through the tax system are one of the most popular, 'fashionable' (Pottelsberghe 2008) policy instruments which have rapidly gained widespread acceptance. In 2006 20 OECD countries had special R&D tax incentives in place, up from only 7 in 1986.

Notwithstanding the world-wide enthusiasm for R&D tax incentives, the empirical evidence of their effectiveness is mixed. Most, but not all, econometric studies have found R&D tax incentives have a significant effect on business R&D.[4] However, some authors have noted that this finding does not appear to be reflected in anecdotal observations of firm activity (Rashkin 2007). While the efficacy of tax incentives on R&D activity of domestic firms has received some attention in recent literature, the role of host country tax policy in driving and directing the globalisation of R&D remains relatively unstudied. The existing empirical evidence is at a nascent stage and previous studies have failed to reach a consensus as to whether MNE behaviour is amenable to tax incentives.

Successful R&D policy must take into account the enormous contribution multinational enterprises (MNEs) make to global R&D activities and the increasing scope for firms to contract

---

[1] For example, in 2000, European Union member countries agreed to the Lisbon Agenda which set as a goal an increase of R&D investment intensity to 3% of GDP by 2010. Many other countries have also set R&D expenditure targets and goals. For example, Canada aims to increase R&D intensity to the level of the top five countries in the OECD by 2010. The increased emphasis on R&D effort is not limited to OECD countries. For example, China recently committed to achieving an R&D intensity of 2.5% of GDP by 2020.
[2] For empirical evidence see for example Lichtenberg (1992), Coe and Helpman (1995) or BLS (2008). The perceived importance of technological progress was further highlighted with the emergence of 'new' or 'endogenous' growth theory in the 1990's (developed by Lucas 1988; Romer 1990; Grossman and Helpman 1991; Aghion and Howitt 1992).
[3] For example, Jones and Williams (1998) estimate the optimal investment in R&D to be about four times greater than existing rates in the USA.
[4] Using firm level data Hall (1992a) finds an elasticity of between -1.5 and -2.5; Dagenais et al (1997) finds a fragile effect, concludes an elasticity of -0.7- to -1; (Eisner 1984) finds no effect; Thomas et al (2003) also find no effect in countries with dividend imputation systems in place. Estimates based on cross country data have suggested a short run elasticity of tax price of between 15 and 30 per cent and a long run elasticity between -.33 and about unity. (Guellec and Pottelsberghe 2000; Bloom, Griffith et al. 2002).

R&D across international borders. MNEs conduct nearly two thirds of total global business R&D (UN 2005). Furthermore, R&D conducted or financed by foreign firms constitutes a significant proportion of total national R&D in most OECD countries – an average of 30% in the countries for which data was available for this study. Clearly, "R&D subsidies and policies need to be assessed against the behaviour of multinationals." (Gregory 1993 p.336).

The case that tax incentives are attractive to foreign firms is theoretically ambiguous. On one hand firms operating across international borders have the ability to arbitrage research costs between national jurisdictions implying subsidies may be more important to them than to local firms. The alternative view emphasises the powerful incentives MNEs face to centralise R&D functions that will only be overcome where R&D is essential to support host country production or to tap into new sources of technology, and therefore that these factors will dominate considerations of cost. Even assuming cost is a principal determinant of the location of some MNE R&D projects, elements of the broader tax environment in which MNEs operate may make tax incentives an ineffective way to reduce R&D costs.

This study aims to throw some light on this sparsely researched issue based on an analysis of a panel data set for 25 OECD countries over up to 25 years between 1980 and 2005. An encompassing empirical model is estimated examining the determinants of cross-border R&D investment with a focus on the efficacy of tax incentives. One important innovation of this paper is to employ a more detailed measure of R&D tax policy. Analogous to industrial production, the globalisation of the production of knowledge (i.e., R&D) is proceeding via a number of distinct channels. R&D attributable to foreign firms include R&D undertaken by MNE affiliates as well as R&D contracted to unaffiliated domestic firms from abroad. Existing data do not support delineation between different types of foreign R&D. In this paper two overlapping subsets of R&D attributable to foreign firms are considered - R&D performed by MNE affiliates, and R&D financed from abroad. R&D undertaken by MNE affiliates includes R&D undertaken by the affiliate for its own use as well as R&D undertaken on behalf of the parent firm. R&D financed from abroad reflects direct transfers that are both intended, and used, for R&D. R&D financed from abroad includes transfers between MNE affiliates and between unaffiliated firms. To my knowledge, there is no recent comprehensive study of the determinants of foreign financed R&D, which is an important and growing subset of R&D investment.

The paper is organised as follows: in section 2 mechanisms of foreign investment in R&D are described, factors that motivate cross-border investment are discussed and the measures of foreign R&D used in this study are introduced. In section 3 the basic trends and patterns suggested by these measures are outlined. Section 4 focuses on the efficacy of tax incentives in influencing foreign R&D, outlining both the theory and existing evidence. Section 5 outlines the model and approach proposed by this study. The empirical results are presented in sections 7 and 8. Section 9 concludes.

2. The Globalisation of R&D

The globalisation of R&D refers to all R&D activity that is attributable to foreign firms. This includes R&D by MNE affiliates and R&D financed from abroad. In this paper two intersecting measures are considered - foreign financed R&D and R&D undertaken by MNE affiliates.

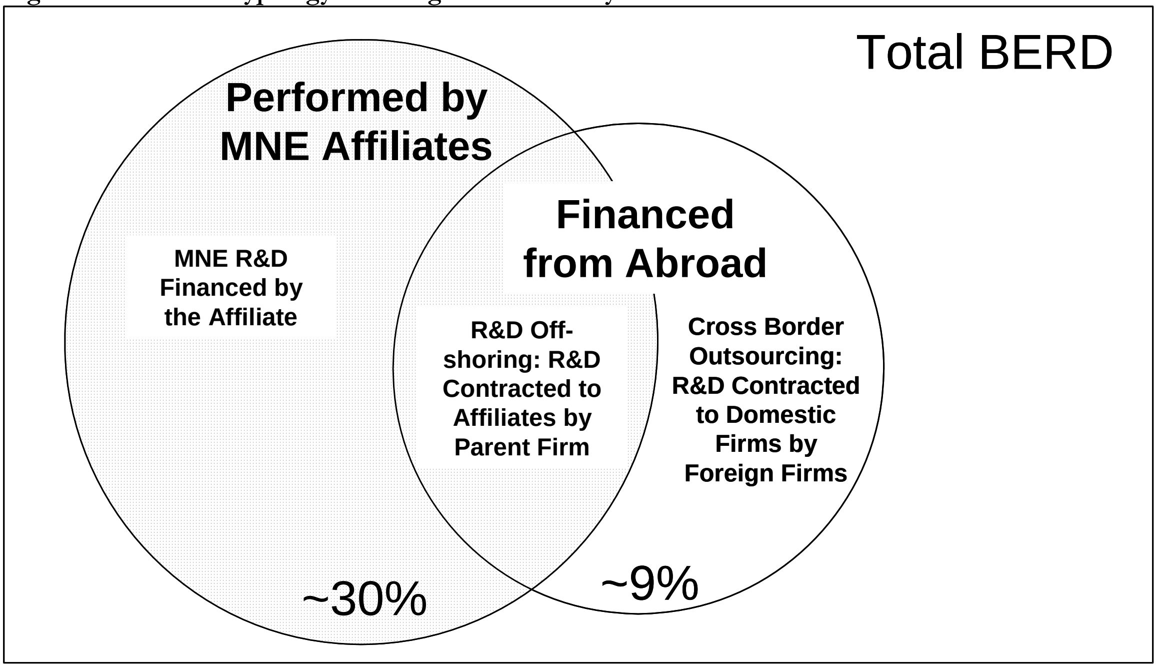
The criteria for recording R&D as 'financed from abroad' stipulates that "there must be a direct transfer of resources [and] the transfer must be both intended and used for the performance of R&D" (OECD 2002a). Foreign sourced loans or other general capital raising is not recorded as foreign financed R&D, these would be recorded under own funds. R&D financed from abroad will therefore be referred to as R&D contracted from abroad. For the countries considered here, 9% of business expenditure on R&D (BERD) is typically financed from abroad. Cross-border contracting or foreign financed R&D includes transactions between MNE affiliates (arms-length) as well as transactions between unaffiliated firms (international outsourcing). It is not possible to assess what proportion of total foreign financed R&D each of these comprises.

In the countries considered here, foreign owned MNE affiliates contribute around one third of total host country BERD. R&D undertaken by MNE affiliates includes both that financed by the affiliate itself (out of retained earnings) and R&D contracted by the parent firm. Generally, "[MNE] affiliates pay for most of their own R&D, but parent companies often enter into contracts with their affiliates to carry out specific research" (OECD 1998b p.11). There is little formal analysis or data available as to the mix of objectives of R&D undertaken by MNE affiliates. In the case of US MNEs, perhaps 80% of R&D conducted by affiliates is for the direct use of the affiliate (i.e., self funded R&D) (see discussion in section 3).

Figure 1 provides a schematic representation of definitions or categories of foreign R&D. In summary, R&D activity attributable to foreign firms including R&D investment by MNE affiliates (foreign owned firms) and R&D contracted to unaffiliated host country firms from abroad. In this study two measures are considered.

- R&D financed from abroad includes R&D performed by MNE affiliates contracted by the parent firm *and also* cross-border contract R&D financed by unaffiliated foreign firms.
- R&D undertaken by MNE affiliates includes R&D financed from the affiliates own revenues and undertaken to support the affiliates host country business operations as well as R&D contracted from the parent firm.

Figure 1 Schematic Typology of Foreign R&D Activity



Source: Author

2.1. Theoretical Framework

Dunning (1988a; 1988b; 1994) proposes an eclectic paradigm for understanding MNE activity which highlights the ability of MNEs to solve the range of market failures associated with intangible assets such as technology. In this view, technology is an important source of ownership advantage (Cantwell 1989) and MNEs "exist for the purpose of reaping the benefits of fixed investment in knowledge in markets that are as big as possible" (Weder and Grubel 1993 p.496). The framework identifies opposing forces that act to centralise R&D activities to the home country and others that act to disperse MNE R&D activities to host (foreign) countries. These are referred to as centripetal and centrifugal forces, respectively (Caves 1996).

Traditionally, MNEs conduct the majority of their R&D in the home country, and there are well-established reasons for this. Technology and business know-how are amongst MNEs' principal sources of competitive advantage; arguably these are the raison d'être of the MNE. As a result, R&D has long been seen as an inseparable part of the 'core business' of MNEs. The desire to protect and control technology and technology creation underpins a powerful incentive to centralise R&D functions in the home country. Centralising R&D activities in the home country also facilitates economies of scale in research.

Centrifugal forces, on the other hand, promote the locating of R&D activities away from a firm's home base. R&D necessary to support local production and to adapt products for local markets has a long recognised history (UN 2005). This is known as *asset exploiting R&D* as it is conducted to exploit existing firm ownership advantages and technological know-how (Dunning 1994). Asset exploiting R&D is generally associated with the need to co-locate R&D and production activities. Firms typically undertake asset exploiting R&D when products sold into different markets require modification to meet local regulation or to cater to different consumer tastes. It may also be associated with R&D supporting resource extraction. Asset exploiting R&D investments represent the globalisation of R&D that occurs as a by-product of the internationalisation of production and distribution.[5]

The potential benefits of spreading the fixed cost of asset exploiting R&D over larger total sales suggest that host country market size may be an important determinant of R&D investments by MNE affiliates. Similarly, it has been argued that that affiliates that serve larger export markets will be more likely to undertake R&D (Athukorala and Kohpaiboon 2006). However, there exists some debate as to the impact of export orientation of an MNE affiliates R&D activity. For example, it has been argued that production is exclusively focused on serving a unique host country markets may be associated with more market specific adaptive type R&D (Lall 1979).

It has been suggested that in recent years "technology seeking" has become an increasingly important motive for investment in R&D outside MNE home country (Athukorala and Kohpaiboon 2006). A recent survey of CEOs concluded that successful MNEs should aim to "access the best capabilities, knowledge and assets from wherever they reside in the world and apply them wherever required in the world." (IBM 2008). This is called *asset augmenting R&D* and is motivated to the acquisition of technology and research capacity. Such cross-border investments in R&D aim to overcome a limited supply of technical skills in a domestic market or to capture spillovers from technology clusters and international centres of excellence (Cantwell 1995; UN 2005 p.121). The availability of high quality, low cost human capital is an important determinant of asset augmenting R&D.[6]

Cross-border R&D contracting between unaffiliated firms represents a second distinct mechanism of R&D globalisation. Cross-border R&D contracting between unaffiliated firms is a specific type of R&D outsourcing or 'open innovation.' There is evidence that the prevalence of R&D outsourcing is increasing.[7] Several drivers of the trend toward 'open innovation' have been

---

[5] The need to undertake R&D proximate to the location of production does not appear to have diminished in the face of growing production fragmentation and the emergence of the 'global factory' phenomenon. In many cases, the increasing range of production activities undertaken outside the MNE home country underpins a corresponding spread of process related technological innovation. For example, flat screen technology, one of the major recent innovations in consumer electronics, was largely developed in the region of production, particularly Taiwan and Korea (Rowen et al. 2006).

[6] Home countries stand to potentially derive substantial benefit from their firms engaging in asset augmenting R&D investments abroad. On this basis, it may be argued that R&D conducted abroad by domestic firms warrants support such as tax incentives.

[7] For example, contract R&D doubled in the United States between 1998 and 2001 (UN 2005 p.177). In the UK, it increased from 5.5 to 10% of BERD between 1985 and 1995 (Howells 1997). In Australia, the proportion of

identified. R&D outsourcing can be driven by the need to bring in specific technical skills or equipment. The development of complex products that incorporate an increasing number of technologies may benefit or even require input from multiple specialised firms (UN 2005 p.168). For example, Nokia gave up making its own silicone chips, once a source of company pride, because "Nobody can master it all," (Engardio, Einhorn et al. 2005).[8] Related to this there are also potential advantages arising from economies of scale, for example, optimally utilising investments in expensive specialised technical equipment. Outsourcing is also thought to infer benefits relating to speed, responsiveness and flexibility in achieving R&D tasks, especially relative to developing R&D capacity de novo (Howells 1997). Finally, it has been suggested that the trend is also supply driven as universities seek to undertake more contract work from the private sector in response to cost pressures (UN 2005).

It has further been suggested that contract R&D and technology outsourcing is becoming increasingly internationalised (Howells 1997; Engardio, Einhorn et al. 2005). One example is Microsoft outsourcing software development activities to India. In addition to the advantages outsourcing R&D identified above, outsourcing *to foreign firms* can generate significant cost savings, particularly where the contracted firm is located in a country with relatively low costs and an abundant supply of highly skilled researchers.

However, it should be recognised that the powerful incentives for firms to maintain R&D activities 'in house' and in the home country apply equally – arguably more so – in the case of contract R&D. The relationship between BenQ and Motorola provides an illustrative example of the perils of international R&D outsourcing. Motorola contracted not only the manufacture but also the design of cell phones to BenQ. Subsequently, BenQ began selling phones under their own brand leading to the termination of the contract with Motorola (Engardio, Einhorn et al. 2005).

Indeed, the growth of outsourcing, to both domestic and foreign firms, appears inconsistent with the existence of strong incentives for firms to maintain control over their intellectual assets. Distinguishing between core research and more 'routine' product development may help reconcile this apparent inconsistency. Outsourcing is considered more appropriate for "translating prototypes into workable designs" and the industrial design phase, while the "really hard technology work" that is critical to firms' competitive advantage remain in house (Engardio, Einhorn et al. 2005). This is suggestive that the types of R&D that are suitable for international contracting may be less subject to the market failures that typify innovation. As a consequence,

---

business R&D undertaken by the scientific research industry increased from 3 to 6% over the 13 years to 2003 (ABS Cat. 8140 various years).

[8] The quote is Pertti Korhonen the Chief Technology Officer of Nokia.

R&D undertaken under contract for foreign firms may be subject to lower technical risks and associated with fewer positive spillovers than R&D undertaken by domestic firms. On this basis it may be argued that the rationale for subsidising such activity may be lower than domestic 'in house' R&D.[9]

2.2. Measuring the Globalisation of R&D

This study considers three measures of R&D internationalisation aggregated to the host country level. These are: business performed R&D that is financed from abroad (OECD 2007a); R&D conducted by affiliates of US MNEs in manufacturing (BEA various years); and total R&D conducted by all foreign affiliates in all industries (OECD 2007a). The first two are employed in the regression analysis aimed at assessing the factors which influence foreign R&D. The third measure, R&D performed by all affiliates in all industries, is used for comparative purposes in the descriptive section. However, the coverage of this data is too limited to provide a basis for formal econometric analysis.

R&D investment by US MNEs in manufacturing is taken from the BEA annual survey of US investment abroad (various years).[10] The series covers 25 countries between 1990 and 2005. As previously noted R&D expenditure by foreign controlled affiliates includes both a foreign financed component and a component financed from retained earnings (OECD 2005c). In other words, affiliates perform R&D both to serve their own immediate business needs, and potentially on behalf of the parent firm for broader application across the parent firm's operations around the globe.

BEA survey data are collected by industry of the affiliate and as such it is possible to delineate R&D in the manufacturing sector. Focussing specifically on the manufacturing sector enables a deeper investigation into firm level attributes that drive the off-shoring decision. This is because it can be better matched with general MNE assets in the host country. The manufacturing sector is also highly representative of total trends in R&D by foreign affiliates. In 1999, the manufacturing sector accounted for 90% of total R&D conducted by MNE affiliates, but less than half of MNE affiliate fixed capital stock (plant and equipment).

MNE investment in R&D can be 'green-field' or can entail the acquisition of existing R&D facilities. It has been suggested that green-field is more likely in an asset exploiting exercise

---

[9] Note that a necessary condition for policy desirability is that R&D expenditure is influenced by tax policy. A sufficient condition would compare the positive spillovers associated with additional R&D induced by the incentive with the efficiency losses arising from raising revenue elsewhere, and then compare the net surplus with alternative public investments (Hall 1995b).

[10] BEA data in this study came from two sources. For the years 1991-1999, data previously compiled by Athukorala and Kohpaiboon (2006) was provided by the authors. Data for the years 2000-2005 were obtained directly from the BEA annual survey reports.

while the acquisition of existing foreign R&D facilities is a comprehensive way to obtain new technological and research expertise (UN 2005 p.170). Acquisitions of large capital assets are not directly included in the BEA data, but the measures include amortisation and depreciation. [11]

The second principal indicator of cross-border R&D activity is business R&D financed from abroad, taken from OECD Main Science and Technology Indicators (OECD 2007a). The criteria for recording R&D by source of funds stipulates that "there must be a direct transfer of resources [and] the transfer must be both intended and used for the performance of R&D" (OECD 2002a p.114). It does not include foreign sourced loans or other general capital raising which would be recorded under own funds. It also does not include R&D performed by MNE affiliates and financed through retained earnings or general transfers from the parent firm.

R&D financed from abroad essentially reflects R&D contracted by foreign entities. It includes R&D activity of MNE affiliates contracted by parent firms as well as cross-border R&D sub-contracting between non-affiliated firms. In theory, it can also include contracts from foreign governments and NFPs, for example defence procurement. However, it is anticipated that this represents a very small amount because, for a range of reasons,[12] governments generally award R&D contracts to domestic firms.

Each of these three alternative measures of the dependent variable has its own advantages and limitations. The advantage of using R&D expenditure by affiliates of US MNEs is that it can be matched with firm data regarding sales, industry, export orientation and fixed capital stock of affiliate firms. The advantage of using R&D financed from abroad is the scope of coverage, which for many countries is available from 1981-2005. Further, as these measures reflect somewhat different aspects of the globalisation of R&D, it is therefore anticipated that they will be amenable to different influences. In particular, it is postulated that as R&D financed from abroad is more affected by cost or technological capacity advantages of the host country, whereas R&D undertaken by MNE affiliates will depend more directly on the location of production and other MNE assets.

3. Trends and Patterns in the Globalisation of R&D

The aim of this section is to describe the distribution and trends of foreign R&D. Figure 2 depicts three measures of foreign contribution to business R&D - R&D conducted by majority owned affiliates of US MNEs, R&D financed from abroad, and R&D conducted by all MNE

[11] The BEA survey form states that respondents should: "Include all costs incurred in performing R&D, including depreciation, amortisation, wages and salaries, property, taxes and other taxes (except income taxes), materials and supplies, allocated overhead, and indirect costs." but "Exclude capital expenditures" (BEA 2004)

[12] For example relating to issues of security or arguments regarding national interests of supporting domestic firms.

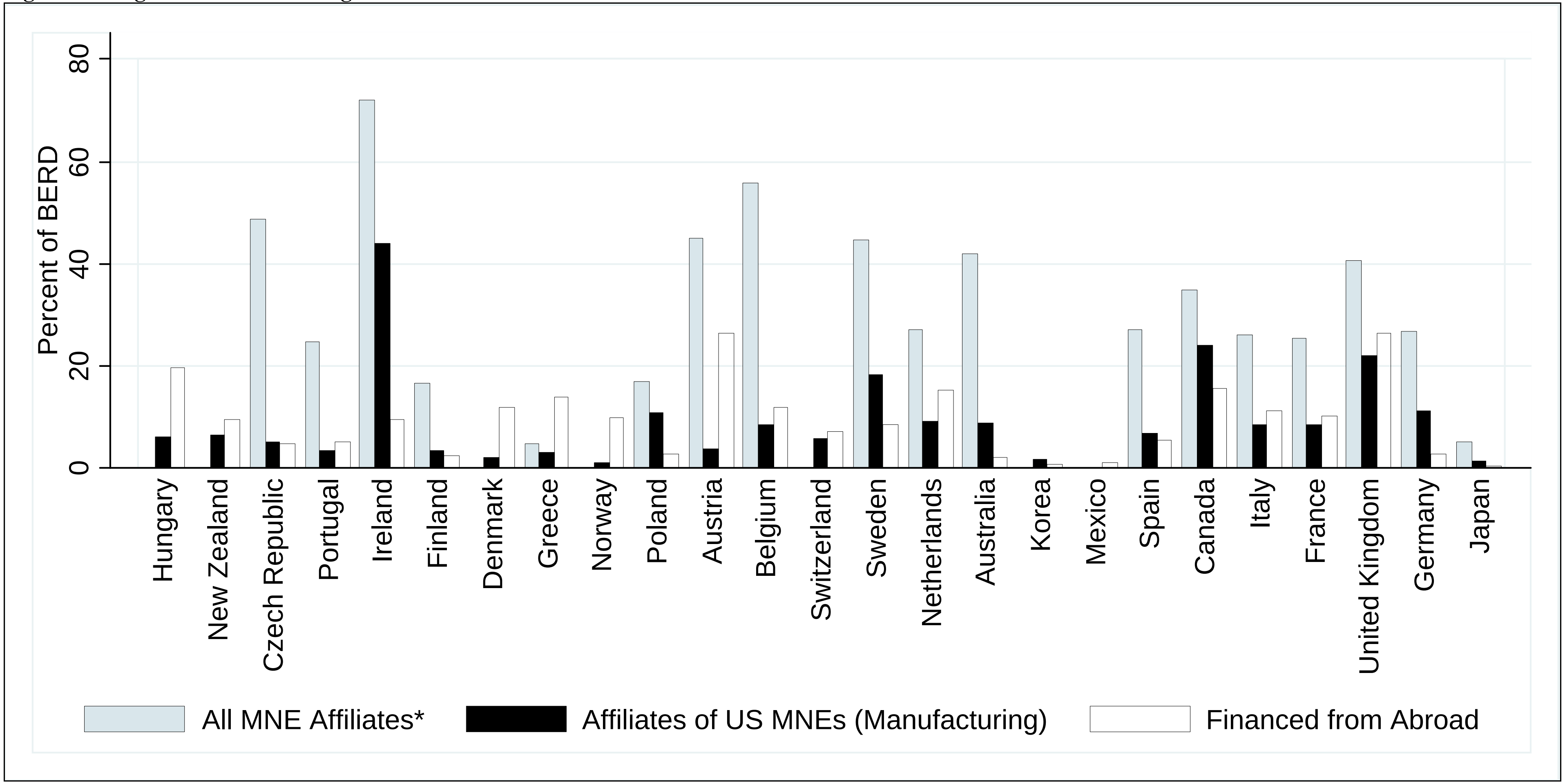
affiliates. These are expressed as a percentage of aggregate national BERD for 2004. Countries are ordered from left to right according to increasing GDP. The blue-grey bars represent R&D expenditure by all foreign affiliates in all sectors. Because of data availability theses figures reflect the nearest available year though this varies between 1999 and 2004. Even so, data are not available for every country in the sample. The available data clearly demonstrates the substantial contribution of MNE affiliates to national R&D. The unweighted average contribution of foreign MNE affiliates to national BERD is 33%.

Data on the R&D expenditure of majority owned affiliates of US MNEs in manufacturing are represented by the black bars in Figure 2. To remove the effect of short run volatility the average for the years 2003-2005 is reported. The unweighted average contribution of US MNEs to national BERD is nearly 10%. As can be seen from Figure 2 this varies substantially between countries. For instance, in Ireland it is over 40%, while in Japan it is less than 1.2%. Based on available data, US MNE affiliates in the manufacturing sector contribute on average about one third of all R&D conducted by MNE affiliates.

In Figure 2, the unfilled bars depict foreign financed R&D. As discussed, this includes parent firms contracting to affiliates as well as contracts between unaffiliated firms. R&D financed from abroad is significantly less than total expenditure by MNEs. Across the sample, on average, just under 10% of BERD if financed from abroad, though again there is considerable variation between countries.

These indicators reveal that foreign firms contribute an unusually low proportion of BERD in the case of Japan. Ireland is at the other end of the spectrum. In Ireland, MNE affiliates, and particularly affiliates of US MNEs, appear to contribute far more than in the average country in the sample. In Austria, Greece, Hungary and the UK, the share of business performed R&D that is financed from abroad is atypically high. The high proportion of R&D financed from abroad in Austria was examined by Gassler and Nones (2008). They claim that the "high share of foreign financing is a result of the considerably high amount of foreign ownership of Austrian industry" (Gassler and Nones 2008 p.410). However, comparing between countries depicted on Figure 2 reveals that a high contribution of MNE R&D is not necessarily associated with a high proportion of R&D *financed* from abroad. Consider for example in Germany and Australia the large contribution of MNE affiliates to R&D is not accompanied by large foreign financed R&D.

Figure 2 Foreign R&D as a Percentage of BERD 2004



Source: Compiled from BEA and OECD MSTI. Countries are arranged from left to right in increasing total GDP.
* Note figures for R&D performed by all MNE affiliates reported reflect the 2004 figures with the following exceptions: 1999 is shown for Greece and Australia and 2003 is shown for Germany, Ireland, Netherlands, Portugal, and Sweden.

As noted, there is little existing evidence regarding whether R&D undertaken by MNE affiliates is generally for own use or contracted by the parent firm. The BEA *Annual Survey of US Investment Abroad* reports the composition of R&D conducted by US MNE affiliates every 5 years. Figure 3 shows the proportion of R&D undertaken by US MNEs for the affiliate itself by host country.[13] It is likely that much of the remainder reflects R&D performed under contract for parent firms. The cross section depicted reflects the average of the years 1994, 1999 and 2004.[14] While there is some variation between countries, it seems most R&D conducted by MNE affiliates is performed for their own use. This evidence is consistent with previous research by Hines and Jaffe (2001) who report that an average of 80% of R&D undertaken by US MNE affiliates was self financed in the 1980's and early 1990s.

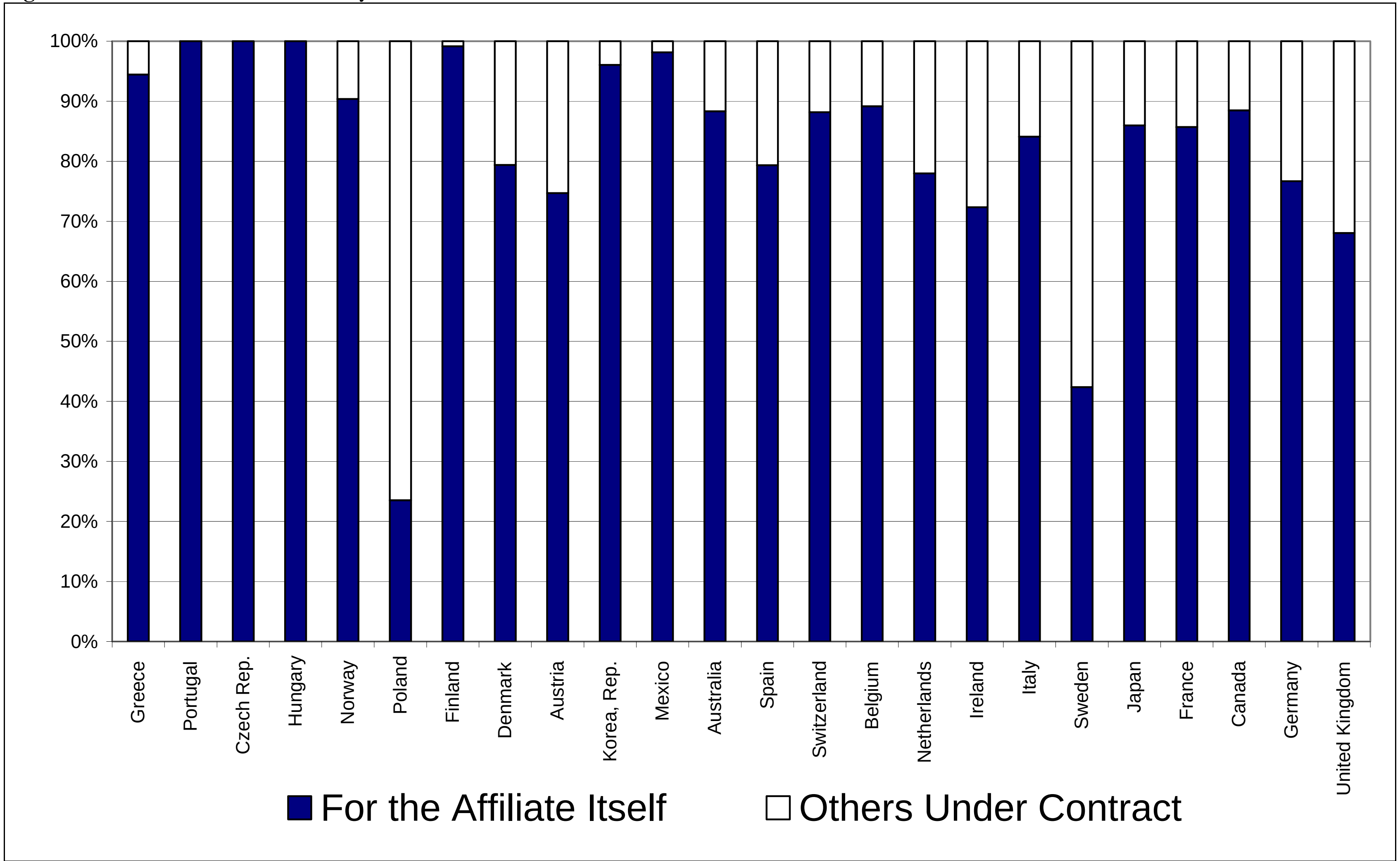
Most R&D undertaken by MNE affiliates is for their own use which implies only a small proportion of R&D undertaken by MNE affiliates represents R&D undertaken for other firms under contract, including the parent firm. According to this data, less than 20% of R&D undertaken by MNE affiliates is financed from abroad. In contrast to the conclusion of Gassler and Nones (2008), it does not necessarily follow that countries in which MNE affiliates undertake a large proportion of total BERD will exhibit a high proportion of R&D financed from abroad.

To illustrate trends in foreign R&D, Figure 4 depicts the average annual growth rate of each measure between 1991 and 2005 (unless stated). For comparative purposes the growth rate in total BERD is also depicted. In the countries where the growth rate of foreign R&D is larger than the growth rate of total BERD it can be inferred that the proportional contribution of foreign R&D has increased. The average annual growth rate of R&D by affiliates of US MNEs in the manufacturing sector is also depicted. It can be seen that in most OECD countries the contribution of foreign firms to total BERD has increased. Notable exceptions are Australia and Canada.

[13] The exact wording of the survey question is "127. For the foreign affiliate's own account" or "128. For others (including U.S. parents) under contract" (BEA 2004)

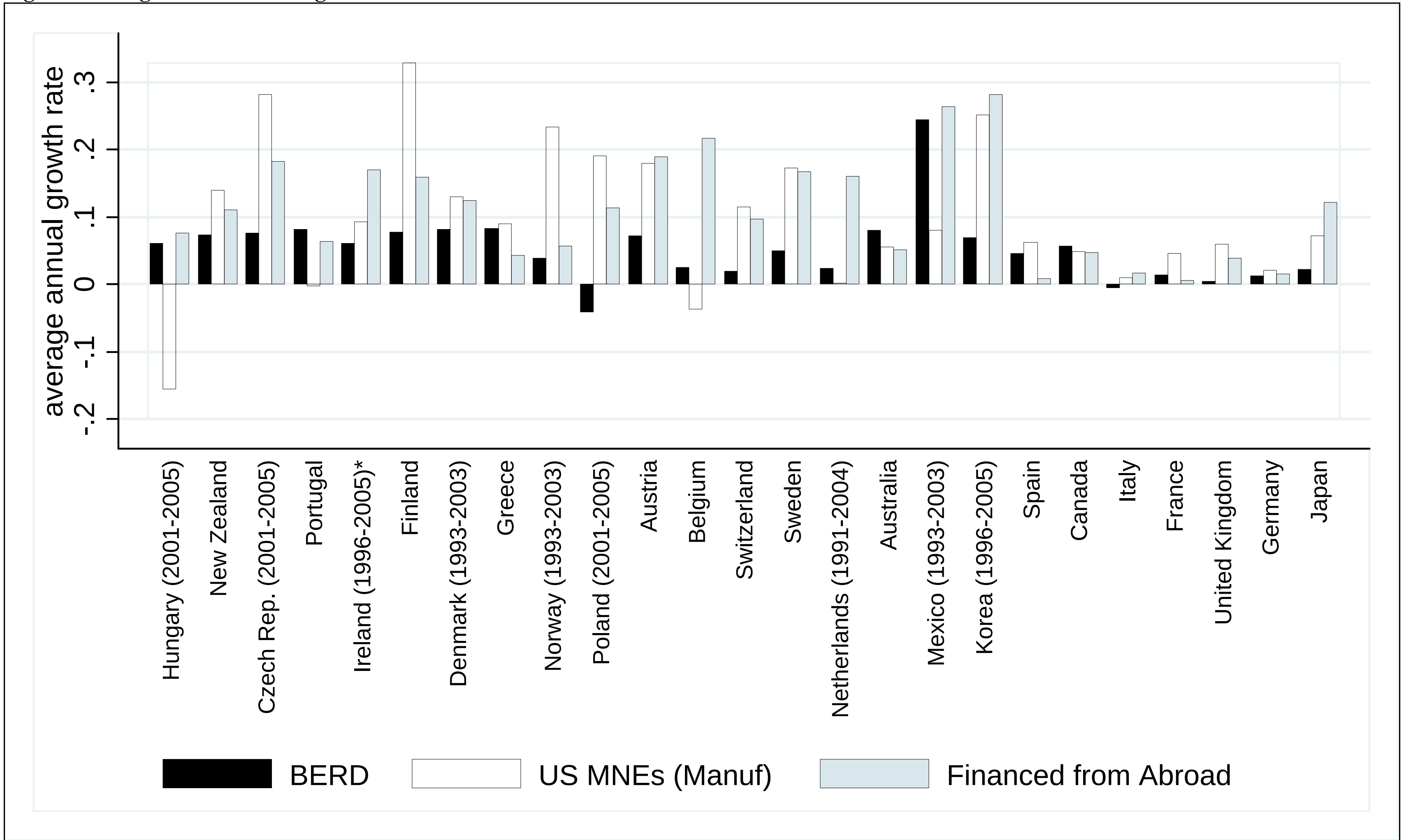
[14] For the countries considered, this data shows no overall trend but does show some volatility

Figure 3 Percent of R&D Performed by US MNE Affiliate that is for Own Use



Source: BEA (various years) the data refer to an average for 1994, 1999 and 2004.

Figure 4 Average Growth in Foreign R&D 1991-2005



Source: Compiled from OECD (2007a), BEA (various years). See notes section 2.2

Countries are ordered from left to right according to increasing GDP

* Data on R&D investment in Ireland before 1996 appears anomalous, see note at Appendix 6.1.

4. Tax Incentives and Foreign R&D

The increasing internationalisation of R&D has led policy makers in many countries to consider what steps can be taken to attract greater MNE R&D activities and R&D contracting from abroad. This study aims to investigate the determinants of cross-border R&D investment with a focus on the efficacy of tax incentives. Tax incentives are seen as an important policy instrument available for governments to attract a share of increasingly globalised R&D activities (OECD 2002b). However, the case that tax incentives are attractive to foreign firms is complex and theoretically ambiguous.

On one hand, MNEs and firms engaged in cross-border contract R&D can arbitrage research costs between national jurisdictions. On this basis it may be argued that subsidies and tax incentives are more important to these firms than to local firms. On the other hand, there are several reasons why MNE behaviour may be less amenable to the influence of cost considerations. The framework outlined in section 2.1 proposed that MNEs commonly invest in R&D abroad in order to exploit particular local markets or production resources or alternatively in an effort to capture technological spillovers from international centres of excellence. This suggests R&D is not 'footloose' but rather that cost factors are secondary considerations in determining the location of R&D and as a corollary that tax policy will be ineffective.

The observation that R&D activity by MNEs is generally concentrated in technologically advanced countries appears to provide prima facie evidence that it is national technological capability rather than cost factors driving the location decision (Kumar 2001). On the other hand, a recent UN (2005) report observes substantial growth in MNE R&D investment in developing countries, particularly in China and India, possibly reflecting an increasing role for cost considerations.

Even if cost is an important determinant of the location of some MNE R&D projects, elements of the broader tax environment in which MNEs operate may make tax incentives an ineffective way to reduce R&D costs. For example, the way foreign income is treated for taxation purposes by the home country has important implications for the attractiveness of host country tax incentives. For example, US MNEs pay tax on all global income but tax paid to foreign governments is credited against US company tax liabilities (Hall 1995b). That is, tax paid to foreign governments is reimbursed via reductions in IRS liabilities. In this case, firms only stand to benefit from tax incentives where they have excess unused foreign tax credits. It is also important that taxation on outgoing royalties may also influence MNE location decisions (Feldstein, Hines et al. 1995).

4.1. Review of Recent Studies

Existing empirical evidence regarding the impact of tax incentives on MNE R&D investments is at a nascent stage and does not yet point to an emerging consensus.

Bloom and Griffith (2001) provide indirect evidence of the footloose R&D hypothesis and by extension a role for host country tax incentives. Their study considers the impact of the weighted average[15] foreign tax price (i.e., tax price in other countries) on domestic investment in R&D. The hypothesis is that foreign user cost will influence the choice of location for domestic firms' R&D investment. If R&D is footloose, domestic firms will move some of their R&D activities overseas in response to lower user costs abroad. Implicit in this argument is that domestic and foreign R&D are substitutes.

Bloom and Griffith (2001) estimate the short run elasticity of R&D with respect to *domestic* user cost of about 0.15 and the long run elasticity is just over unity, which is reasonably consistent with previous studies. The weighted average foreign user cost is found to be insignificant when considered over the whole sample. However when United States is dropped from the sample, the coefficient on weighted average foreign user cost is positive and significant. The short run elasticity is found to be –0.75 and the long run elasticity –5.3.[16] That is, the long run effect of a 1% decline in the weighted foreign user cost of R&D will reduce domestic firms' R&D in the home country by 5.3%. This is interpreted as strong support for the footloose R&D hypothesis. It is noteworthy that their results suggest the weighted average foreign user cost has a stronger effect on domestic R&D than domestic user cost. This estimate of the response of domestic firms to changes in tax policy abroad might be considered implausibly high.

Athukorala and Kohpaiboon (2006) examine the role of host country characteristics in determining the location of international flows of BERD R&D investments. The dependent variable is R&D expenditure by US MNE affiliates in manufacturing aggregated to the host country level. The data covers the period 1990-2001. Their model includes variables intended to capture the role of product adaptation, domestic technological competency, domestic investment environment and other factors including industry structure. Contrary to Bloom and Griffith (2001), they find tax incentives have no statistically significant effect on MNE R&D investments. Athukorala and Kohpaiboon (2006) suggest the positive finding in previous studies may be the result of omitted variable bias.

---

15 Weighted by FDI flows

16 Results are $\ln(R\,\&\,D) = 0.854\ln(R\,\&\,D_{t-1}) - 0.153Ln(DomesticUC) + 0.775\ln(ForeignUC) + ...$ suggesting a long run elasticity of $\frac{0.775}{1-0.854} = 5.3$

The period covered by the study (1990-2001) saw substantial change to R&D tax policy in many countries. However, the measure of tax policy applied by Athukorala and Kohpaiboon (2006) is a simple ordinal indicator that reflects the policies in place in 2000-2001. This measure does not reflect the many policy changes over this period. As such, in most periods, this will be a poor indicator of the actual prevailing tax treatment of R&D in each country.

Hines and Jaffe (2001) consider the effect on MNE patenting activity of tax-driven changes to the cost of undertaking R&D in the United States relative to the cost of undertaking it abroad. This is a firm level study covering two periods, before and after a policy reform. Growth in patents attributable to R&D from each host country is expressed as a function of (a) changes in the price of undertaking R&D in the United States for the domestic market, (b) change in the price of undertaking R&D in the United States for foreign markets, and (c) changes in patents attributable to domestic R&D. The Estimates reveal that when the cost of undertaking R&D in the United States for use abroad is reduced, patents originating in foreign countries increase. This is interpreted to imply that R&D performed by MNEs in the USA and in host countries are complements. The authors extrapolate from the apparent response of MNEs to tax incentives that "foreign tax incentives should influence the rate at which US multinationals innovate in their domestic markets" (ibid p. 203).

Feldstein and Hines (1995) provide further indirect evidence as to the efficacy of tax policy in influencing MNE behaviour. The authors consider BEA data on US MNE's expenditure on R&D to assess the response of R&D/sales ratio to variation in taxes levied by host country governments on royalty payments for foreign technology. The results suggest that increased tax on royalties actually increases R&D investment in the host country. This result is interpreted to imply, not only the strong impact of tax consideration in driving MNE behaviour, but also that R&D and technology transfer (licensing etc) are substitutes. In his comments on the paper, Jaffe (1995) notes that the estimates of the effect of royalty taxes seem implausibly large, as they imply affiliate R&D investment responds more to the variation in royalty tax than royalty payments do.

5. Model and Approach

In this study, two separate models are estimated using the two different dependent variables: R&D investment by US MNEs in manufacturing and R&D financed from abroad. Variables included in each model are based on the same overarching theoretical framework. These include attributes of the host country, and attributes of the investing firms.

Host country attributes include cost considerations, supply of human capital and host country technological capacity. The same host country characteristics are included in both models. The second group of variables relate to the attributes of the investing firm. Important factors include the size, industry and market orientation of affiliate operations which underpin the need for either adaptive R&D or 'asset exploiting' behaviour. The explanatory variables relating to firm attributes are different for each model. This is because the dependent variables represent the activities of different groups of firms.

5.1. Host Country Factors

Measuring Tax Incentives

Tax treatment of R&D differs between countries, particularly in regard to the design and implementation of incentives. Policies differ in their treatment of various types of expenditure; types of tax incentives including deductions, allowances and offsets; and, the definition of eligible expenditure.[17] To assess the efficacy of R&D tax incentives it is necessary to have some way of comparing between these diverse policy designs. A standard measure of the relative generosity of a tax system is known as the b-index. The formula for the b-index is given by

$$B = \frac{1-A}{1-\tau} \qquad (0.1)$$

where A is the net present discounted value of all reductions to tax liabilities resulting from one dollar of R&D and τ is the corporate income tax rate.

The b-index represents the before tax project hurdle rate i.e., the minimum before tax return the marginal R&D investment must generate to be financially viable after tax (Warda 2006).[18] Note that the lower b-index reflects more generous tax treatment of R&D. It is sometimes described as the tax price of R&D because it is the price a firm is willing to pay for the marginal investment. The b-index is multiple of Jorgenson's (1963) the user cost of capital and as such the elasticity can interpreted identically. The measure is extremely flexible and can accommodate a wide range of implicit and explicit tax incentives. Observe that variation in the measure comes from both changes in tax credits and allowances, and also from variation in CIT.

Various years of this index have been prepared by the OECD (see in particular OECD 2006 p.242). Unpublished OECD data are also cited in a few recent studies (Guellec and Pottelsberghe 2003; Falk 2006). For this paper, an audit of national tax policies for 25 countries between 1980 and 2005 was undertaken from a wide range of sources. This enabled an expanded series to be calculated based on consistent methodology and assumptions. Full details of the

17 An overview of tax policy design can be found at Appendix A

18 The name of the b-index is short for the benefit cost ratio at which an R&D investment opportunity becomes viable after tax (Warda 2001).

R&D tax policy in the sample of countries and construction of the index can be found at appendix A.

The measure calculated here aims to capture the principal features of depreciation, deductions and special credits applicable to all large firms. The measure constructed for this study follows standard assumptions, first outlined by McFetridge and Warda (1983), based on the average effective rate of subsidy assuming firms make a constant R&D investment in real terms; or more specifically "a constant R&D – sales ratio in the presence of constant real sales" (ibid p. 32).

A review of aspects of host country R&D tax policies, in particular as they pertain to foreign firms, was undertaken. Based on information available, tax incentives are not restricted by foreign ownership in any country. However, the tax system in France, Korea and Switzerland and all policies in place by which foreign firms undertaking R&D can be granted tax holidays (Rashkin 2007). For this reason, it is considered important to test the robustness of results considering the determinants of MNE R&D expenditure on a sample excluding these countries.

Few countries seem to have limitations on claims for foreign contracted R&D. Australia has had the most explicit restriction. In Australia, R&D conducted on behalf of another firm is not eligible to receive enhanced deduction (BIE 1993; ATO 2002).[19] The scheme in Portugal also requires that the claimant must self-finance at least 25% of the total investment (IBFD 2004 p.154). No information regarding such restrictions in any other countries could be identified.[20] The restrictions in Australia and Portugal are unlikely to significantly affect the attractiveness of R&D tax incentives to US MNE affiliates. Recall from section 3 that most R&D undertaken by MNE affiliates is undertaken for their own use and therefore self funded. Further, the restrictions do not rule out all foreign financed R&D from eligibility for tax incentives. For example, IP created through R&D that is funded in part by a foreign parent (or subsidiary) can remain the property of an eligible host country based establishment and be subsequently licensed to parent and other affiliated firms. To address these issues, a modified version of the b-index was calculated that does not include the special incentives in Portugal and Australia. This alternative 'foreign contract' b-index is denoted by BFC.

---

[19] However, a special scheme was introduced in 2007 to provide enhanced deduction for foreign contract R&D. This reform is outside of the period of this study.

[20] The absence of restrictions was positively confirmed in the case of Austria, Canada, Ireland and the UK which do not require that claimants of tax incentives to own or exploit resulting IP (Canadian Embassy Berlin 2003; IBFD 2004; IRC 2005; McAlpine 2005). In some countries, including Belgium and France, taxpayers cannot claim R&D expenses that are contracted out to other firms (IBFD 2004). However, this does not appear to limit the contracted firm from claiming expenses. In the case of France some ambiguity existed prior to 2007 though it seems contracted firms did claim R&D expenses (DTT 2008).

It is important to acknowledge some of the other limitations of the measure and potential sources of measurement error. The calculations assume that firms can benefit fully from the incentive, i.e., it assumes firms have sufficient tax liabilities to claim the full amount of R&D tax incentives in the current year. Also, the standard methodology does not consider caps and floors in the scheme. It does not incorporate subtle and complex differences in the definition of qualifying expenditure. The measure does not incorporate differences in tax treatment of dividends or withholding taxes on international transfers of profit.

Other Host Country Factors

Recall that firms undertake asset exploiting R&D when products sold into different markets require modification to meet local regulations or to cater to different consumer tastes. On this basis, larger host country markets may justify greater investment in adaptive R&D. Real GDP is included in the current analysis to capture market size.

The other host country attributes that determine the extent of foreign R&D relate to asset augmenting R&D activities. These attributes include host country technological capacity, the supply of human capital as well as cost factors including labour costs and the availability of R&D tax incentives. These factors are anticipated to underpin the decision to contract R&D overseas, whether within a MNE or between unaffiliated firms.

Academic research is commonly considered an important source of R&D investment opportunities. This is reflected by the fact that published scientific research is commonly cited as prior art in patent applications (see for example Branstetter 2003). To control for host country technological capacity and opportunities for foreign firms to tap into cutting edge research the model includes the aggregate number of articles published in international journals on science and engineering (WB 2007). Scientific and technical journal articles refer to the number of peer reviewed scientific and engineering articles published annually, by location of the institution of the author. Technical publications are essentially an output based measure of performance of academic research (NSF 2008).[21]

While this measure has the great advantage of being widely available both across country and over time, it is acknowledged it is a somewhat noisy measure of R&D investment opportunities. This is because some scientific research, such as advances in material science or biochemistry, may have many commercial applications while other published research, perhaps in the field of theoretical physics or pure maths, may have little immediate commercial value. Journal article publications are also recognised to have an English language bias (NSF 2008)

[21] Scientific and engineering articles published in the fields of physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.

which, like other time invariant heterogeneity, must be taken into account when estimating the model.

R&D performed by the tertiary education sector (HERD) provides a proxy for the quality and extent of postgraduate research education. HERD includes research by students at the PhD level including supervisory costs but does not include expenditure in relation to coursework degrees and teaching related activities (OECD 2002a). This measure is superior to the percentage of the population with tertiary education because it also has superior coverage and it will more directly reflect both the number as well as the quality of research based degrees, which is of primary interest.

MNEs face strong incentives to maintain control of intellectual assets. A strong host country intellectual property right (IPR) regime may encourage MNEs to undertake R&D without fear of imitation. However the impact of IPR is somewhat more complex in an international context. It has been conjectured that stronger IPR may facilitate technology transfer via licensing. In as much as foreign licensed technology and domestic R&D are partial substitutes IPR reform may have a negative impact on R&D investments.

Existing evidence on the role IPR play in determining MNE R&D decisions is mixed, and it's role in directing the cross border outsourcing market has not be faced empirical scrutiny. More recent evidence suggests IPR to be an effective determinant of MNE R&D investment. Kumar (1996; 2001) finds in most estimates, that IPR does not affect location of MNE R&D. Conversely, Branstetter et al (2006) and Athukorala and Kohpaiboon (2006) find IPR strength to be a statistically significant determinant of R&D by US MNEs.

Two different approaches for measuring IPR strength have been adopted in the empirical literature. One is based on assessing legislation (e.g., Rapp and Rozek 1990; Ginarte and Park 1997) and the other is based on surveying key stakeholders (e.g., Mansfield 1994). Measures based on qualitative reviews of legislation are the most common in econometric analysis. Legislative based reviews are argued to reflect a higher degree of objectivity, thereby allowing for consistent treatment of policy over time. However, reviews of prevailing legislation have been criticized for not sufficiently reflecting enforcement in practice (Branstetter, Fisman et al. 2005). The extent of this issue is likely to be minimal across the OECD countries considered here as they are all expected to have similar enforcement of legislated protections.

Ginarte and Park's (1997) IPR score based on national legislation is employed in the current analysis to account for the role of IPR strength. The IPR score is coded out of 5 and calculated at half decade intervals. The Park IPR score exhibits substantial variation over the sample with a standard deviation 13% of the mean. This is a high level of variation given the sample of countries considered are typically associated with strong institutional quality and broadly similar approach to private property rights. Despite its limitations this index remains probably the best available means for controlling for this theoretically important determinant of R&D investment in cross-country empirical analysis.

To control for the cost of R&D labour, average labour compensation for the total host country economy is included, taken from OECD Outlook (various years). This is converted to current USD and deflated using US GDP Deflator (WB 2007). It is proposed that this captures relative changes in labour costs over time across-country, particularly those arising from large movements in exchange rates. A limitation of this measure is that it will also reflect the employment composition of each nation,[22] though to the extent that this remains constant over time this can be addressed using fixed effects estimation.

5.2. Firm specific factors

Firm specific drivers of R&D internationalisation relate to asset exploiting motives such as the need to support local production and to adapt products for host country markets. As discussed, the two alternative dependent variables represent the activities of different groups of firms. For this reason, different variables reflecting the attributes of investing firms are used in each model.

Determinants of R&D by Affiliates of US MNEs

Asset exploiting R&D is predicted to increase with the scale of MNEs operations in a host country host country. To control for the scale of host country operations the regressions explaining R&D investment by MNE affiliates include the book value of plant and equipment, as well as total sales.

Export orientation of MNE affiliate has a theoretically ambiguous impact on the requirement to undertake R&D. On one hand, production assets that serve large export markets may justify greater investment in R&D. On the other hand, production that is set up solely to serve the host country market may be indicative of specific host country market requirements and therefore associated with greater affiliate R&D. To test these hypotheses, export orientation, given by total exports divided by total sales, is included in the model.

Industrial composition will be a key explanatory as to the R&D investment by foreign firms. This is because some industries are typically more R&D intensive than others, reflecting differences in technological opportunity or technological maturity. For example, retail or other

[22] The ideal variable would be total compensation of a 'standardised' unit of research labour. Another possible proxy would be the real wages of researchers. However a complete time series for all countries included in the sample was not available.

service industries typically have lower R&D intensity. The data on R&D investment by US MNEs considered here is restricted to the manufacturing sector, effectively controlling for the influence of the industrial composition of FDI.

Determinants of R&D Financed from Abroad

R&D financed from abroad reflects R&D undertaken on behalf of foreign clients. The output of this R&D may be for application in the host country or abroad. The observed incentive to keep R&D functions 'in house' implies that a large share of foreign financed R&D is likely to represent transactions between parent and affiliate firms. At the same time, given some foreign financed R&D will reflect transactions between unaffiliated firms it does not automatically follow that foreign financed R&D will be a function of the scale of total foreign firm activity in the host country.

To investigate this issue further, FDI stock is included as a control variable in the regressions explaining R&D financed from abroad. FDI stock for each host country is imputed from total FDI inflows reported in WDI (WB 2007) using the perpetual inventory method assuming a depreciation rate of 5% and that the initial FDI stock is zero. Where available, pre-sample FDI flow data from 1975 are employed in this calculation.

Similarly, it is preferable to have some control for the industrial mix of foreign firm operations when considering R&D financed from abroad. Unfortunately, time series data on the industry profile of all foreign firm activity (i.e., industrial composition of total FDI stock) is not available for the entire 20 year series for each country. As an alternative the model includes total manufacturing value added (WB 2007) to control for national industrial specialisation. It is proposed that the industrial composition of the economy as a whole is likely to be related to a host of factors that will independently drive innovative performance.

6. Specification and Estimation

The eclectic paradigm does not give rise to an obvious structural equation. Traditional investment equations derived from neoclassical or convex adjustment cost models[23] assume firms' R&D decision aims to optimise technology stock. Structural equations derived explicitly from optimal stock models include total output (using technology stock) as a control variable. However, in the case of foreign R&D, the technology produced may be applied both to production in the host country or abroad. This implies the modified neoclassical model is inappropriate.

[23] From which Q-theory equation or Euler equations are derived.

The empirical starting point is a simple linear log-log model. When estimating the model, it is important to take into account unobserved time invariant heterogeneity. Unobserved characteristics include language and historical ties to large investor nations. It is also important that several control variables are correlated to important fixed effects. Scientific journal article publications have an English language bias (NSF2008). Average labour compensation reflects industrial structure and institutional factors that will also evolve slowly over time and can therefore largely be controlled with fixed effects. Other important time invariant determinants of foreign R&D include geographic factors such as distance to major markets and the MNE head office. Therefore, on a priori grounds, fixed effects estimates are preferred. Year dummies are also included to control for global technology shocks and shifts in the global investment and trading architecture that affect firms in all countries.

There are reasons for and against the appropriateness of a dynamic specification. On one hand, once MNEs set up R&D facilities their utilisation may persist for some time. Similarly, the relationships and communication channels opened up through cross-border R&D contracting may be utilised repeatedly once one project is successfully completed. On the other hand, speed and reflexivity are sometimes considered important benefits of the R&D outsourcing. A dynamic specification has not been widely applied in the literature concerning international investments in R&D (see for e.g., Kumar 1996; 2001; , and Athukorala and Kohpaiboon 2006).

6.1. Summary of the Models

In summary, different models are estimated for each dependent variable: for R&D conducted by affiliates of US MNEs in the manufacturing sector (RDUS) and for R&D financed from abroad (RDFABR). Host country variables are the same in each model. However, variables intended to capture attributes of the investing firm operations in the host country are different. The two models, including variable definition and data summary are given below:

Model (1) R&D undertaken by affiliates of US MNEs:

$$RDUS_{it} = \beta_0 B_{it} + \beta_1 LC_{it} + \beta_2 GDP_{it} + \beta_3 HERD_{it} + \beta_4 SJA_{it} + \beta_5 IPR_{it} + \beta_6 EO_{it} + \beta_7 PE_{it} + \beta_8 SALES_{it}$$

Model (2) R&D financed from abroad:

$$RDFABR_{it} = \theta_0 B_{it} + \theta_1 LC_{it} + \beta_0 GDP_{it} + \beta_1 HERD_{it} + \beta_2 SJA_{it} + \beta_3 IPR_{it} + \gamma_1 K_{itt} + \varepsilon_{it}$$

Table 1 Variable Definitions and Economic Concepts

Variable	Economic Concept	Measure
Host Country Attributes: Common to Both Models		
LC	Labour costs	Average Labour Compensation Rate (USD per Employee)
B	R&D Tax Policy	B-Index
GDP	Host country market size	GDP
HERD	Supply of skilled researchers	R&D performed by Higher Education Sector
SJA	Technological Capacity	Scientific and Technical Journal Article Publications
IPR	Intellectual Property Rights	Park (1997) IPR Score
Firm Level Attributes: Model 1, US MNE Affiliates		
PE	Total Fixed Capital Stock in the Host Country	Value of Plant and Equipment (Survey value)
EO	Export Orientation of Affiliates	Exports / Total Sales
SALES	Scale of Operations in host country	Affiliate Total Sales
Firm Level Attributes: Model 2. R&D financed from Abroad		
FDI	Total Fixed Capital Stock in the Host Country	Total FDI Stock
MANUF	Industry composition	Manufacturing value added

6.2. Data Summary

The data used in each set of estimates are presented in Table 2 and Table 2 below. Data are constructed from the range of sources previously discussed. Missing data for control variables are interpolated linearly. This interpolation generally bridges between bi-annual survey data of HERD. The dependent variable is not interpolated in this way.

Table 2 Data Summary Model 1: R&D Performed by Affiliates of US MNEs in Manufacturing

		Obs	Mean	Std. Dev.	Min	Max
RDUS	*R&D undertaken by Affiliates of US MNEs ($m)*	264	695	973	1.16	4,092
B	Tax Price of R&D (b-index)	264	0.95	0.10	0.57	1.06
LC	Average Labour Compensation Rate (USD per Employee)	264	31,810	11,006	5,819	61,314
GDP	GDP ($b)	264	743	1,048	48	4,885
HERD	R&D performed by Higher Education Sector ($m)	264	2,982	4,289	77	21,122
SJA	Scientific and Technical Journal Article Publications	264	15,742	15,233	990	57,228
IPR	Intellectual Property Rights	264	3.92	0.51	2.57	4.86
PE	Fixed Capital Stock (Plant and Equipment) ($m)	264	8,616	10,623	89	47,834
SALES	Affiliate Total Sales	264	37,393	46,517	403	231,796
EO	Export Orientation of Affiliates (Exports/ Total Sales)	264	0.33	0.17	0.03	0.69

Table 3 Summary of Data Used in Foreign Financed R&D Regressions

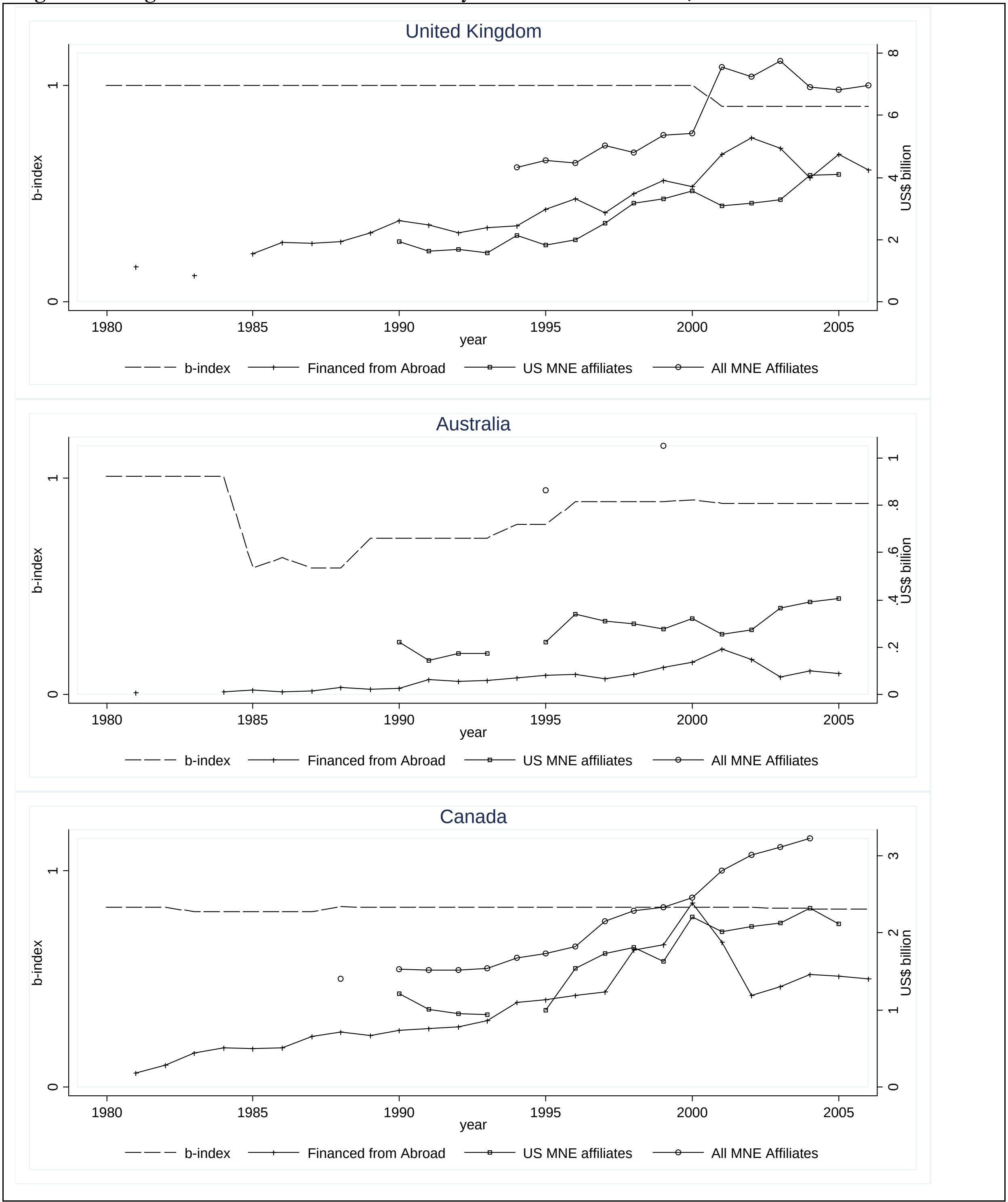
		Obs	Mean	Std. Dev.	Min	Max
RDFABR	R&D financed from Abroad ($m)	407	441	809	0.62	5,285
B	Tax Price (b-index)	407	0.96	0.11	0.57	1.08
LC	Average Labour Compensation Rate (USD per Employee)	352	28,976	10,641	5,775	61,314
GDP	GDP ($b)	407	664	973	38	4,885
HERD	R&D performed by Higher Education Sector ($m)	407	2,454	3,925	35	21,122
SJA	Scientific and Technical Journal Article Publications	407	13,290	14,126	184	57,228
IPR	Intellectual Property Rights	407	3.66	0.65	1.63	4.86
FK	FDI Stock ($m)	407	60,310	89,996	484	490,341
MANUF	Manufacturing value added ($m)	407	142,126	225,620	7,105	1,098,437

6.3. A First Look at the Data

This section examines the univariate relationship between tax price and measures of R&D investment from abroad in order to set the scene for interpretation of the results of the multivariate regression analysis. Figure 5 depicts b-index (tax price) against the three measures of foreign R&D investment for a sample of countries. These countries are chosen for illustrative purposes. Patterns in these countries are reasonably representative and more importantly they have higher than average data availability. In all three countries, both series of foreign investment in R&D are characterised by a general upward trend.

Both foreign financed R&D and R&D expenditure by majority owned affiliates of US MNEs exhibit a substantial variation over time. There is no obvious relationship between either measure of foreign R&D and the tax price (b-index).

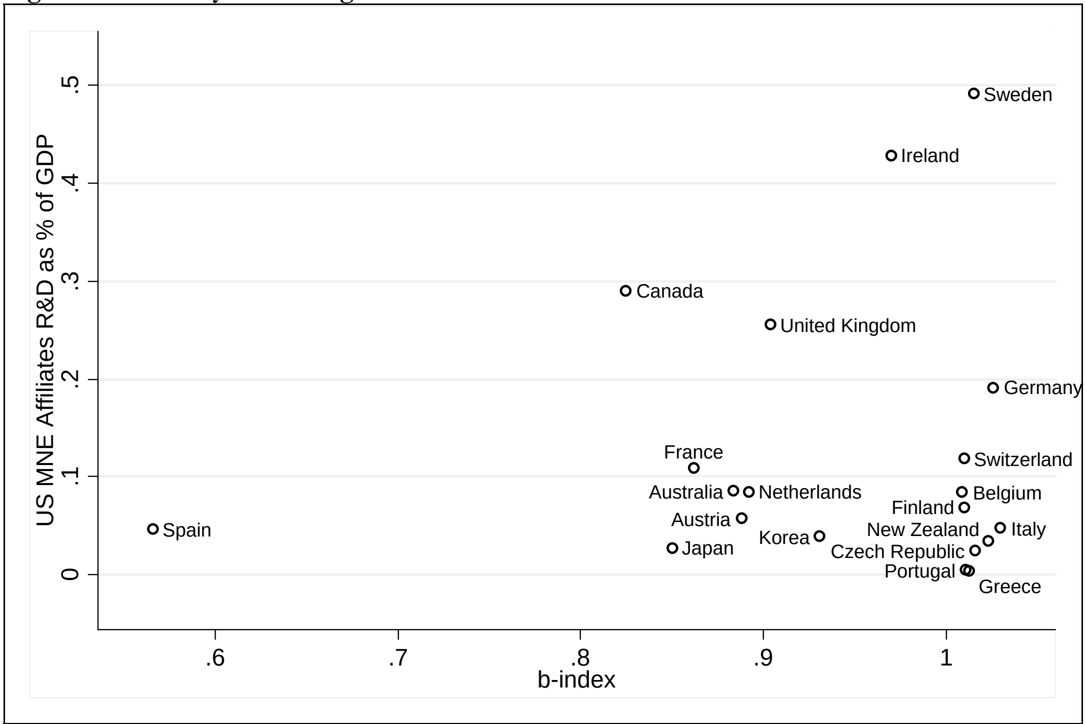
Figure 5 Foreign R&D investment and Tax Policy 1982-2005 Great Britain, Australia and Canada

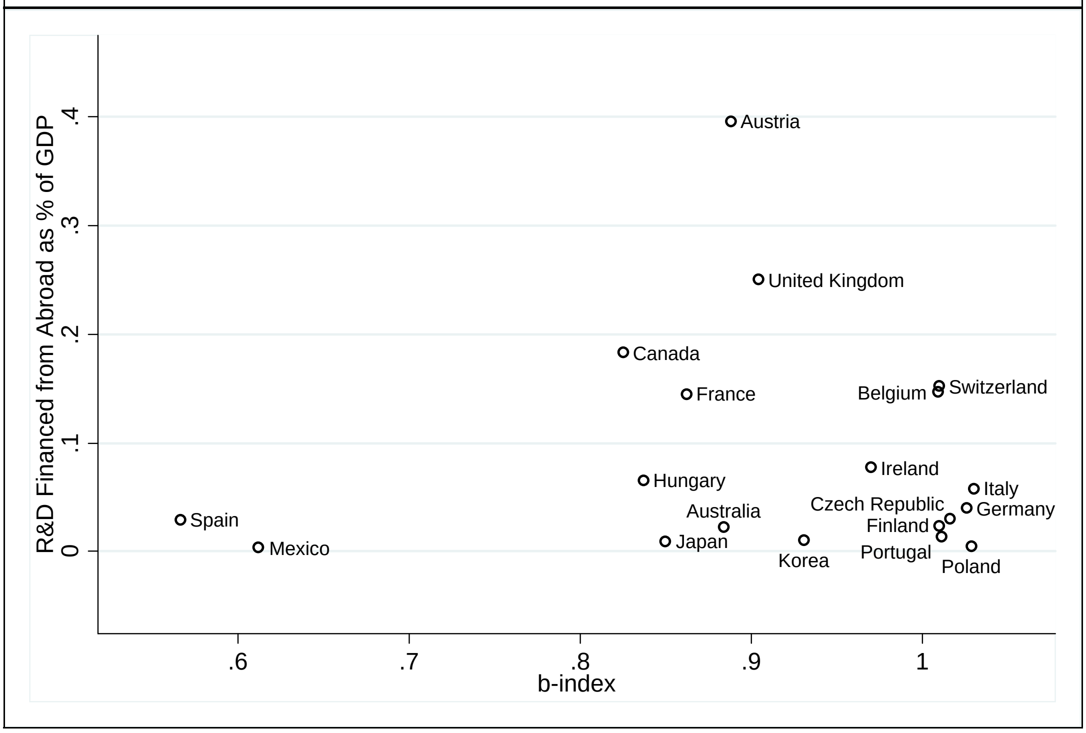


The distribution of each measure of foreign R&D against national b-index in 2004 is depicted in Figure 6. The upper panel shows the R&D investment by affiliates of US MNEs expressed as a fraction of host country GDP. The generosity of the R&D tax policy in Spain shows it to be somewhat of an outlier at that time. The lower panel depicts the b-index against R&D financed from abroad expressed as a percentage of host country GDP. Figure 6 shows that there is no clear relationship between tax policy and foreign R&D. Several countries with relatively generous tax policy such as Spain, Mexico and Japan exhibit low foreign R&D intensity. Conversely countries like Sweden and Germany that have less generous tax treatment of R&D have attracted substantial foreign R&D.

Over the pooled sample (including all years), the univariate correlation between the b-index and R&D by MNE affiliates is actually positive (0.05), though it is small and negative for R&D financed from abroad (-0.06).

Figure 6 Tax Policy and Foreign R&D 2004





7. Results for Model 1: R&D Expenditure by US MNE Affiliates

Table 4 presents the regression results for model 1, considering the determinants of R&D investment by affiliates of US MNEs in the manufacturing sector. Column (I) presents random effects (RE) estimates and column (II) presents fixed effects (FE) estimates. These exhibit some important differences. Using RE, the coefficient on tax price is positive and significant which is contrary to theoretical expectations. As already noted, there is substantial reason to believe a range of unobserved time invariant effects, including cultural, linguistic and geographic factors, may result in omitted variable bias. The FE estimates, presented in column (II), control for unobserved time invariant heterogeneity. According to the Hausman test, the difference between the FE and RE estimates is statistically significant at 1% and as such the fixed effects estimates are preferred.

The results in column (II) suggest variables associated with asset exploiting R&D are important determinates of MNE R&D investment. The coefficient on aggregate MNE affiliate plant and equipment stock is positive and significant. The magnitude of this coefficient suggests that doubling of total MNE capital stock in a host country is associated with a 49% increase in R&D. Similarly, the results suggest R&D investment increases as affiliate total sales increase. Ceteris paribus, an increase in affiliate sales is reflected in an 80% increase in R&D investment. These results also suggest that the more export oriented an MNE affiliate sales are, the more R&D the firm is likely to undertake which is consistent with recent evidence (Athukorala and Kohpaiboon 2006).

Turning now to factors associated with asset augmenting, or knowledge seeking, R&D the results find no evidence that these are important determinants of R&D investment by US MNEs. R&D undertaken by the higher education sector, the proxy for availability of high level human capital, is not significant. Rates of publications in science and engineering journals are also not found to be significant.

The strength of national intellectual property rights is positive and significant at the 10% level. The coefficient on the index suggests an increase of one point on Park's (1997) IPR scale is associated with a 27% increase in R&D. It is not simple to interpret the quantitative effect of this ordinal IPR index. Some sense of scale can be garnered by noting that an increase of this magnitude is roughly commensurate with the IPR reform in Australia in 1995 which increased patent duration from 16 to 25 years. Based on this, it might be argued that the size of the coefficient is implausibly high.

Neither of the measures associated with cost of R&D is found to be significant. Labour compensation rate is not found to be significant. Importantly, the measure of tax policy, the b-index, is found to have no explanatory power of the amount of R&D undertaken by affiliates of US MNEs in manufacturing.

Table 4 Regression Results R&D performed by Affiliates of US MNEs

	(I) RE	(II) FE	(III) FE	(IV) GMM
$RDUS_{t-1}$			0.533*** (0.085)	0.487*** (0.19)
B_{t-1}	1.098*** (0.29)	1.616 (0.99)	0.903 (0.70)	0.780 (0.49)
LC_{t-1}	0.0885 (0.19)	-0.477 (0.35)	-0.252 (0.32)	-0.335 (0.28)
GDP_{t-1}	-0.542*** (0.14)	0.142 (0.63)	-0.0182 (0.47)	0.249 (0.63)
$HERD_{t-1}$	0.780*** (0.21)	-0.00346 (0.27)	-0.0341 (0.22)	-0.101 (0.24)
SJA_{t-1}	0.209 (0.18)	0.208 (0.25)	0.0653 (0.15)	0.119 (0.18)
IPR_{t-1}	0.0832 (0.12)	0.270* (0.15)	-0.00281 (0.14)	0.111 (0.20)
EO_{t-1}	0.165*** (0.052)	0.583*** (0.16)	0.413*** (0.15)	0.447*** (0.17)
PE_{t-1}	0.488*** (0.15)	0.487** (0.20)	0.217 (0.18)	0.193 (0.22)
$SALES_{t-1}$	0.425*** (0.16)	0.784*** (0.16)	0.376** (0.17)	0.403* (0.21)
Observations	264	264	243	207
Countries	22	22	22	21
Rho		0.80	0.74	
m1, m2, S				0.0; 0.45; 0.36

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All variables are in logs and estimates include time dummies

Columns (III) and (IV) present estimates of a dynamic version of the model including a single lagged depended variable. The dynamic model tells a reasonably consistent story with the static version. Column (III) presents FE estimates. With lagged R&D investment included as an explanatory variable only total sales and export orientation remain significant. Applied to a dynamic model such as this, fixed effects estimates may suffer Nickel (1981) bias resulting from the correlation between the LDV and the transformed error term. Differenced GMM estimates are reported in Column (IV). To maximise the data available for the estimation the forward orthogonal deviations transformation rather than first differencing is applied as suggested by

Roodman (2006).[24] The results pass the usual tests regarding over identifying restrictions and the requirement of no second order serial correlation. The GMM estimates generally conform to the estimates under FE, again suggesting export orientation and total sales are key determinants of R&D investment by MNE affiliates.

It was noted previously that large changes in tax price because of major policy reform are very rare and can dominate results. For a further robustness check, the model was re-estimated omitting such observations. This was not found to change the result. The results were tested for omitting the countries that are identified as offering the possibility of tax holidays (France, Korea, and Switzerland) and were found to be qualitatively unchanged.

On balance, the FE results presented in column (II) are preferred. The fixed effects estimator is well justified economically and the resulting estimates of the coefficients conform well to existing priors. It is reassuring that the alternate estimators above are suggestive of a reasonably consistent story, which is to highlight the central role of the asset exploiting motive as a determinant of R&D investment by MNEs.

8. Results for Model 2: R&D financed from Abroad

This section considers the results for model 2, which aims to explore the determinants of R&D financed from abroad. Results are presented in Table 5. RE and FE estimates are presented in columns (I) and (II), respectively. As in the case of R&D by MNEs, FE and RE estimates differ considerably therefore on both a priori economic and statistical grounds the FE estimates are preferred.

Perhaps more importantly, both FE and RE estimates reflect an anomalous coefficient on total labour compensation rate; the proxy which aims to capturing time series variation in R&D labour cost. Both sets of estimates find this to be large and positive which is contrary to the theoretical prediction that firms will contract R&D to host countries with the lowest labour costs. There are a number of possible explanations for this unexpected result. For example, it may reflect an 'efficiency wage' effect. That is, average labour compensation is serving as a proxy for skill mix or the productivity of workers rather than the costs of equivalent R&D labour.

While this interpretation seems plausible, it is prudent to consider the model without labour compensation rate which is generating the counterintuitive sign. The preferred FE estimates omit labour compensation and are reported in column (III).

---

[24] The orthogonal transformation involves purging the fixed effects by subtracting the average of all available future observations rather than first differencing (Roodman 2006). Additionally, to reduce the instrument count the collapse option on xtabond2 command is applied. Described in Roodman (2006)

Table 5 Determinants of Foreign Financed R&D

	(I) (RE)	(II) FE	(III) FE
B_{t-1}	1.276***	-0.152	-0.0515
	(0.43)	(0.48)	(0.47)
LC_{t-1}	1.186***	0.541*	
	(0.25)	(0.29)	
GDP_{t-1}	-0.0952	-0.190	0.487
	(0.32)	(1.01)	(0.73)
$HERD_{t-1}$	-0.109	0.315	0.637***
	(0.23)	(0.24)	(0.23)
SJA_{t-1}	0.937***	0.158	-0.316
	(0.19)	(0.26)	(0.26)
IPR_{t-1}	-0.0864	0.0459	-0.0217
	(0.12)	(0.17)	(0.17)
PK_{t-1}	0.619***	0.449***	0.488***
	(0.055)	(0.088)	(0.074)
$MANUF_{t-1}$	-0.00398	0.731	-0.269
	(0.28)	(0.50)	(0.45)
Observations	353	353	407
Number of cn	22	22	25
Rho	.	0.71	0.67

Robust Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All variables are in logs and estimates include time dummies

Host country market size is not found to be statistically significant. Foreign owned capital stock is the most important determinant of R&D financed from abroad. This suggests that cross-border R&D contracting is in fact strongly associated with the internationalisation of production. The coefficient on existing capital stock is 0.35, about 14% lower than in the case of R&D undertaken by US MNEs (c.f. the coefficient on affiliate fixed capital stock in column (II) of Table 4). This substantial difference means cross-border R&D contracting does not increase as rapidly as R&D by MNE affiliates as the capital stock of foreign firms in a host country increases.

In the preferred estimates, HERD is found to have a positive effect on R&D financed from abroad which is significant at the 10% level. The coefficient suggests increasing HERD by 10% can be anticipated to drive a 6% increase in R&D financed from abroad holding everything else constant. This is important as HERD is generally under the control of government and hence represents a policy option for attracting foreign R&D.

Given the conjecture that cross-border R&D contracts are driven primarily by cost and technology seeking incentives, it is perhaps surprising that journal article publication rate, which reflects technological capacity and opportunities for knowledge seeking R&D, is found to be insignificant in the fixed effects estimates. It is premature to draw strong conclusions but this could reflect that R&D undertaken abroad under contract is not 'cutting edge' core research, but rather reflects more 'routine' product development activities.

Industrial composition and intellectual property rights are not found to be significant. The impotency of host country IPR regime may reflect that firms do not contract out R&D that constitute critical ownership advantages. Alternatively, it may simply be that, across the OECD countries considered in this sample, differences in IPR are not sufficient to influence firm behaviour. As in the case of R&D undertaken by affiliates of US MNEs, tax price is not found to be a significant determinant of cross-border R&D contracting. That is, the results provide no evidence that tax incentives are effective in attracting additional R&D financed from abroad.

Robustness Checking

Additional estimates performed for the purpose of robustness checking. These include estimating a dynamic model and re-estimating the model using the alternative measure of b-index that does not include the tax incentives offered in Australia and Portugal (see section 5.1). The results are presented in Table 6.

The economic rationale for the application of a dynamic model is not considered strong. As discussed previously, it is widely conjectured that an advantage of contract R&D is reflexivity and responsiveness. On the other hand, parent-affiliates relationships are thought to constitute a substantial share of R&D financed from abroad and these may represent more persistent relationships. For completeness, FE estimates of a simple dynamic model with a single LDV are presented in column IV. The results do not contradict the previous findings. HERD and existing FDI stock remain significant in the dynamic fixed effects estimates. Central to the research question considered in this thesis, tax policy as measured by the b-index is not found to be significant at conventional levels.

Estimates using the alternative measure of b-index of the static and dynamic version of the model are included in columns (II) and (III), respectively. These are also entirely consistent with those reported previously.

Table 6 Additional Robustness Checking for R&D Financed from Abroad

	(I) FE	(II) LSDV	(III) FE
$RDFABR_{t-1}$	0.546***		0.544***
	(0.12)		(0.12)
B_{t-1}	0.0454		
	(0.39)		
BFC		-0.507	-0.210
		(0.72)	(0.58)
GDP_{t-1}	0.827	0.384	0.781
	(0.85)	(0.74)	(0.87)
$HERD_{t-1}$	0.523*	0.651***	0.526*
	(0.30)	(0.23)	(0.30)
SJA_{t-1}	-0.266	-0.331	-0.284
	(0.28)	(0.23)	(0.25)
IPR_{t-1}	-0.225	-0.0208	-0.219
	(0.15)	(0.16)	(0.15)
PK_{t-1}	0.272***	0.496***	0.277***
	(0.091)	(0.075)	(0.090)
$MANUF_{t-1}$	-0.428	-0.217	-0.398
	(0.51)	(0.46)	(0.53)
Observations	340	407	340
Number of cn	23	25	23
Rho	0.68	0.78	0.67

Robust Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All variables are in logs and estimates include time dummies

9. Conclusion

In most of the OECD countries considered here foreign firms are responsible for a large and growing share of all R&D activities. This paper has investigated the determinants on foreign R&D investment with an emphasis on the efficacy of R&D tax policy. The empirical analysis is based on a panel of 25 countries over a period of up to 25 years and it considered two overlapping measures of foreign R&D activity. One is R&D undertaken by affiliates of US MNEs and the other is R&D financed from abroad.

It is generally considered that MNEs will tend to concentrate R&D functions in the home base, reflecting a desire to maintain control of commercial advantages embodied in technological assets. However, for a range of reasons, MNE affiliates undertake some R&D in host countries. Traditionally, it has been considered that affiliates undertake R&D in order to support host country production and adapt products to local markets. It has also been argued that MNEs are increasingly engaging in technology seeking R&D. This involves MNEs tasking affiliates to develop technology for application outside the host country, and potentially around the world. This type of R&D is focused on acquiring the best technology at the lowest cost.

MNEs contracting affiliates to undertake R&D on their behalf represent a subset of all foreign financed R&D. Cross-border R&D contracting to unaffiliated firms is a special case of the general phenomenon of R&D outsourcing. Such R&D outsourcing is though to be driven by the need to access outside expertise and advantages relating to speed and flexibility. Outsourcing R&D to foreign firms may have the added advantage of cost savings achieved by arbitraging between locations, particularly where a contracted firm is located in a country with relatively low costs and an abundant supply of highly skilled researchers.

To formally assess the determinants of foreign R&D activity two overlapping measures were considered: R&D undertaken by affiliates of US MNEs and R&D financed from abroad. Two encompassing models were estimated, one for each measure of internationalisation of R&D. Each draws on the same fundamental framework incorporating two broad groups of explanatory variables. The first group relate to host country attributes and these include cost considerations and domestic technological capacity. Estimates employ a measure of tax price of R&D which is a more descriptive measure than has been applied in previous studies. The second important group of control variables relate to the attributes of the investing firms aggregated to the host country level. For example, foreign owned production and distribution assets are thought to reflect the need for adaptive R&D.

In the case of R&D undertaken by MNE affiliates, most R&D is undertaken to support operations within the host country. It is not surprising then that attributes of the affiliate were found to be key determinants of R&D expenditure by US MNEs. The plant and equipment capital stock and total sales of affiliates were both found to be strong determinants of R&D performed by affiliates of US MNEs. Controlling for these factors, host country attributes seemed to be less important, only intellectual property rights were found to be significant, and then only weakly so.

Foreign owned fixed capital stock is also a significant predictor of cross-border R&D contracts. This may reflect that a substantial portion of cross-border contracts are between affiliates and parents. This is contrary to the suggestion that cross-border contracting is driven by the need to outsource R&D functions to achieve greater responsiveness and flexibility. In the case of foreign financed R&D the preferred estimates suggest the availability of graduates with research based degrees is also an important determinant. This is consistent with the prediction that contract R&D will be focused on technological acquisition.

The principal result is that no evidence was found to support the hypothesis that tax incentives are effective in either inducing MNEs affiliates to undertake additional R&D or to encourage additional international R&D contracts. It may be that the intended subsidies provided by the R&D tax policy are 'washed out' in the broader treatment of international transfers of capital and profits. Alternatively, it may be that other factors are dominant in driving cross boarder R&D investment decisions. For example, once firms take into account the supply of workers with research degrees, as well as existing fixed capital assets and the degree to which they are 'embedded' in the country, any potential small cost saving available through the tax system is insignificant.

Appendix A Tax Policy Data and Variable Construction

R&D Tax Policy Design

For the purpose of taxation, R&D expenditure can be categorised as either current expenditure or capital expenditure. Current expenditure includes wages, overheads, costs of materials and other inputs to R&D activity. In all countries considered, current R&D expenditure can be deducted from taxable income in the year it is incurred (i.e., expensed). Capital expenditure includes investment in fixed assets such as buildings and structures (B&S) and machinery and equipment (M&E). Expenditure on capital assets is generally deducted against income tax over a length of time designated by tax law and nominally commensurate with the useful life of the asset.

There are a range of implicit and explicit incentives provided by the tax system of different countries. Important types are accelerated depreciation, deduction allowances, tax credits and tax rebates. Accelerated depreciation is where the rate of depreciation allowable for tax purposes is greater than the rate of economic depreciation. Allowing current R&D expenses to be deducted from current taxable income implicitly constitutes a subsidy, in as much as current R&D expenditure results in a technology asset that generates an ongoing stream of benefit. A second common form of incentive is deduction allowances, which are also known as tax concessions or enhanced deductions. These allow firms to deduct an amount greater than the actual expenditure on R&D. With enhanced deduction, a portion of profits is shielded from corporate income tax (CIT). On the other hand, tax credits reduce tax liabilities directly by some fraction of allowable expenditure. To benefit from accelerated depreciation, deduction allowances or credits, firms must have tax liabilities. This means they must be earning a taxable income. However, if the incentive is given as a rebate (also known as an offset or 'extended access' schemes) firms receive a cash refund irrespective of their profit status. Finally, in a few cases incentives are provided as a reduction on labour related taxes[25] which also do not require firms to be in profit for them to benefit.

A common type of policy, referred to here as an incremental scheme, is where only increases in R&D above a defined base level are eligible for tax incentives. The base can be fixed or moving. In many countries base expenditure is defined in terms of a trailing moving average. For example, in an incremental scheme with a three year moving average base, only expenditure that is over and above expenditure in the previous 3 years is eligible to receive the incentive. The intent of incremental schemes is to direct the subsidy at marginal (new) R&D investment and to

[25] For example, in the Netherlands and Norway

avoid subsidising R&D that would have occurred anyway. Eligible expenditure is also commonly subject to maximum and minimum claims, known as caps and floors.

The definition of eligible expenditure is generally based on the standards outlined in the *Frascati Manual* (OECD 2002a). Qualifying expenditure must commonly demonstrate characteristics such as technical risk, novelty and or creativity (Rashkin 2007). However, the definition of qualifying expenditure differs between jurisdictions. For example, in Australia overheads generally qualify but this is not the case in the UK (McAlpine 2005). Policies in some countries require that R&D be carried out in the host country[26] sometimes using stipulated domestic content, or that any intellectual property resulting from R&D remains the property of the firm receiving the incentive (OECD 2002b). Perhaps more importantly, the eligibility of expenditure on research related fixed capital equipment such as machinery and buildings varies by jurisdiction.

Some countries provide preferential treatment to R&D undertaken by small firms. Two reasons have been used to justify policies that favour small firms. One relates to the 'open innovation' argument, that small firms have a creative advantage in radical innovation, the second is that small firms are subject to greater market failure and so justify greater incentives. Recall that firm size has featured widely as a determinant of innovative advantage. The reasons large firms are commonly predicted to have an advantage include the ability to internalise technological spillovers, risk spreading and economies of scale. The latter does not appear to provide a clear case for intervention as it suggests preferencing small firms may work against industry's endogenous Coasean response to possible market failure.

Several nations provide fiscal incentives with objectives other than purely inducing additional R&D investment. They offer incentives targeted at encouraging collaboration between domestic firms and either the government sector, the tertiary education sector or international research projects. For example, Denmark and Hungary offer incentives for collaboration with the higher education sector at 150% and 400%, respectively (Warda 2006 p.14).

9.1. Assumptions and Calculations

The standard assumptions for the b-index were first outlined by McFetridge and Warda (1983). The assumptions allow comparison between countries with different policies in place. The measure is based on the effective average rate of subsidy for a representative firm assumed to make a constant R&D investment in real terms; or more specifically "a constant R&D – sales ratio in the presence of constant real sales" (ibid p. 32). For example, with an incremental scheme

[26] An increasing number of countries, including Australia, allow some R&D to be performed abroad.

where the base is defined as a trailing k period moving average, the share of income eligible for the incentive is given by:

$$A_c = 1 - \frac{1}{k}\sum_{i=1}^{k}(1+r)^{-i} \qquad (2))$$

In the calculations applied here, the standard assumption of a 10% discount rate is applied.

It is important to note that, in the case of an incremental incentive with the base defined as a moving average, the effective *average* incentive, assuming constant real expenditure on R&D, is equivalent to the *marginal* incentive under the weaker assumption that the firm increases expenditure above the base each period. However, for an incremental scheme with a *fixed* base the marginal and average incentive is not the same. This is because with a fixed base the firm does not take into account the effect of expenditure today on the value of the subsidy in the future.

As is noted previously, current expenditure and expenditure on fixed capital assets are commonly treated differently for tax purposes. The standard assumption is followed that representative R&D investment is comprised of 90% current expenditure two thirds of which represents the wages of researchers (60% total expenditure). The remaining 10 percent of total expenditure is assumed to comprise equally machinery and equipment (M&E) and buildings and structures (B&S). This is reflective of the approximate composition of expenditure reported in industrial surveys (McFetridge and Warda 1983; ABS 1990-2006; Bloom, Griffith et al. 2002)

Depreciation for tax purposes is calculated on a straight line (SL) or Declining Balance (DB) basis, and this is stipulated by the tax system. The formulae used for these are given by: $NPV_{SL} = \frac{1}{T}\frac{1-(1+r)^{-T}}{r/(1+r)}$ and $NPV_{DB} = d\frac{(1+r)}{(d+r)}$ for SL and DB depreciation respectively; where r is the discount rate, or required rate of return.

9.2. Caveats and Limitations

The b-index calculated here aims to capture the principal features of depreciation, deductions and special credits applicable to all large firms. It is important to acknowledge the limitations of the measure and potential sources of measurement error. These are outlined below.

The calculations assume that firms can benefit fully from the incentive, i.e., it assumes firms have sufficient tax liabilities to claim the full amount of R&D tax incentives in the current year. Also, the standard methodology does not consider caps and floors in the scheme. Observe that where caps are binding, the after tax cost of marginal expenditure is zero, while the average after tax cost depends on by how much the cap has been exceeded.

While the measure incorporates differences in rules relating to the eligibility of current and fixed capital assets, it does not incorporate subtle and complex differences in the definition of qualifying expenditure. This is a particularly difficult measurement issue to address because tax law is not always perfectly codified. There is often scope for interpretation of guidelines by both claimants and administrative agencies. For the same reason identifying 'typical' depreciation schedules is also inherently subject to some measurement error.

The measure of R&D tax policy constructed here does not incorporate differences in tax treatment of dividends or withholding taxes on international transfers of profit. There are two important cases where interaction between these taxes and R&D incentives can reduce the effective value of R&D tax incentives to shareholders. The issue arises where shareholders receive tax relief on dividend income commensurate with the CIT already paid by the company.

Dividend imputation systems (DIS) reduce the effective value of the tax incentives to shareholders and are in place in many countries including Australia, New Zealand, France and Canada. DIS allow shareholders receiving dividends to be allocated tax credits for CIT already paid on company profit. DIS aim to avoid double taxation of company profits. In the absence of dividend imputation, company profits are subject first to CIT and then taxed a second time on being paid out to shareholders. With complete imputation, taxpaying shareholders are indifferent to R&D tax incentives provided on company income. This is because a decrease in CIT liabilities, resulting from an R&D tax incentive policy, can lead to a direct increase in the tax paid on dividends.

MNEs repatriating income can face an analogous 'washout' of host country R&D tax incentives. For example, US MNEs pay tax to on all global income but any tax paid to foreign governments is reimbursed via reductions in IRS liabilities (Hall 1995b). This implies that any reduction in host country tax liabilities simply results in increased IRS liabilities.

The measure does not incorporate any other forms of government support such as grants and procurement or general tax holidays that are sometimes available to foreign firms.[27] Several countries, such as Israel and New Zealand have a general preference for providing R&D incentives via direct subsidies or grants rather than through the tax system. However, to allow for this, in the cross country regression analysis aggregate government support for business performed R&D is included as a control variable.

[27] France, Korea, Switzerland and Ireland all have had or do have the possibility to offer foreign firms or companies performing R&D tax holidays. These are difficult to model because government often have discretionary plenary power over which projects are deemed eligible (Rashkin 2007).

Special schemes requiring collaboration with universities or those available only to small firms are not included, primarily because there is no obvious way to model these in a comparable manner. As discussed in the body of this paper, sub-national policies were not modelled. [28]

10. Country Tax Policy Details and Data Sources

Various years of this index have been prepared by the OECD (see in particular OECD 2006 p.242). Unpublished OECD data are also cited in a few recent studies (Guellec and Pottelsberghe 2003; Falk 2006). For this paper, an audit of national tax policies for 25 countries between 1980 and 2005 was undertaken from a wide range of sources. This enabled an expanded series to be calculated based on consistent methodology and assumptions. Sources include McFetridge and Warda (1983) OECD (1996; 2000b; 2002b; 2005a), Warda (1996a; 1996b; 1999; 2001; 2003; 2006), ETAN (1999a; 1999b), IBFD (2004; 2007)

Corporate income tax (CIT) is compiled from a number of sources including: University of Michigan World Tax Database (WTD 2007), World Bank World Development Indicators (WDI), OECD Tax Database (OECD 2007b) and the KPMG Corporate Tax Rate Survey (KPMG 2007). Unless otherwise stated, data applied are based on central government tax rates only from WTD (2007) extended for the more recent years using OECD (2007b). Cases where methodology deviates from this, for example to account for significant taxes levied at the regional level, are detailed.

In what follows incremental incentive schemes are always based on nominal expenditure. Credits are untaxed unless otherwise stated. In some instances it was difficult to confirm 'typical' depreciation schedules for fixed capital assets. Allowable depreciation rates generally vary by specific asset type. The depreciation applied is documented based on the information available. Status quo is assumed unless evidence of a policy shift is available.

Australia

Tax Incentives: A 150% deduction introduced 1 July 1985 and then reduced to 125% from 1 July 1997. From 1 July 2001, companies could also claim an additional 50% (175% total) deduction on incremental expenditure above a 3 year moving average base. Eligible expenditure

[28] It is noted that in some cases sub-national governments offer R&D tax incentives, particularly in the case of federal systems. This is of little concern to the current analysis for the following reasons: The USA is not included; in Australia, State governments do not levee corporate income tax; in the case of Canada These sub-national policies were not modelled because of practical difficulties in collecting historical data on sub-national policies and also because R&D data is aggregated to the national level. Using sub-national incentive rates would then require weighting tax policy against the proportion of national R&D performed in each region. Often state incentives reduce eligibility to national incentives meaning this is unlikely to be a serious limitation. For example, in the case of Canada, the figures estimated here are within 3 decimal places of recent estimates of the b-index for the state of Ontario published by the OECD.

includes current and M&E, except that prior to November 1987 expenditure B&S used for R&D could be depreciated over 3 years and was eligible for the enhanced deduction (BIE 1993; Lattimore 1997 p.94).

Depreciation: M&E (1980-1996) 3 years straight line (SL), (1996-) 5 years SL. B&S: (1980-1986) 3 years SL (Lattimore 1997 p.94). (1987-) 40 years SL.

CIT: 46% (1980-86), 49% (1987-88), 39% (1989-1993), 33% (1994-95), 36% (1996-1999), 34% (2000), 30% (2001-2006) (financial year begins 1 July, for example 1 July 1999- 30 June 2000 is denoted as 1999).

Austria

Incentives: between 1980-1988: 105% deduction for current expenses on R&D.

1988 – 1999, 112% deduction on current expenses for certified inventions was available. If the innovation was commercialised 'in house' the rate was 118% which is the rate modelled here. Cited as Tax law BGBL Nr 4/1988 in ETAN (1999a).

Between 2000 and 2006, the concession included two parts, a 125% deduction available on the volume and 135% on increments above base expenditure defined as a three year moving average (Law BGBL 28/99).

From 2005, firms could opt to take an 8% credit on current expenditure, modelled here as it provides a greater subsidy on the current assumptions.

In addition to these R&D concessions, fixed assets could be deducted at 109% between 1992 and 2002 under a special 'investment allowance' not specific to R&D. This was increased to 115% in 2003. This is modelled here for consistency with several OECD reports (e.g., Warda 2001).

Depreciation: For the years 1980-1983, all fixed assets are deducted at 80% in the first year, followed by the remainder over the subsequent 4 years on a straight line basis (Warda 1983). For the period 1984-2006, depreciation is calculated over 5 and 25 years SL for M&E and B&S, respectively.

CIT: 55% (1980-88), 30% (1989-93), 34% (1994-2004), 25% (2005-06).

Belgium

Incentives: McFetridge and Warda (1983) observe that in 1980 a scheme was in place whereby expenditure above the average in the three years to 1976 was eligible for a 15% augmented deduction (115% of expenditure deducted from taxable income). Under some conditions eligible expenditure could be scaled up, by a maximum of 50% meaning that in principle firms could deduct 122.5% of every incremental dollar (McFetridge and Warda 1983; ETAN 1999b p.12).

However, a European Commission report (ETAN 1999b) notes that "In practice, however this higher figure is never reached". In the absence of additional information the 15% rate is applied (i.e., current expenditure on R&D is deducted at a rate of 115%).

Between 1980-1989, firms could deduct 110% of all expenditure on machinery and equipment over 3 years on a SL basis.

Between 1990-2006 firms could deduct 113.5% of expenditure on fixed assets (B&S and M& E) (Warda 1996b).

Between 1981 and at least 2000, Belgium had a scheme in place whereby firms were granted a flat rate of tax deduction for each additional employee on a research programme (McFetridge and Warda 1983; ETAN 1999a). It was noted in 1999 that the budgetary impact of the scheme was 'negligible'. This is not modelled here.

There is also a reduction on withholding tax on researchers salary that is available for R&D in collaboration with a European university (OECD 2006). This is not modelled here because it represents a scheme not available to all firms.

Depreciation: As noted above, M&E is depreciated over 3 years SL. B&S are depreciated over 20 years SL.

CIT: 48% (1980-1982), 45% 1983-86, 43% (1987-1989), 41% (1990), 39% (1999-2002), 33% (2003-2006).

Canada

Incentives: The R&D tax credit in Canada was introduced in 1966 and has undergone a range of variations since then. See Warda (1983) for a description of the scheme before 1980. Between 1980-82, the scheme consisted of 10% on volume as well as an incremental credit of 50% above a three year moving average base. From 1983 the credit is 20%. Eligible expenditure includes current and M&E. The R&D credit in Canada is taxable, in that current allowable deductions are reduced by the value of the credit. (Bloom, Griffith et al. 2002)

Depreciation: B&S and M&E were expensed (deducted at 100%) M&E between 1979 and 1987 (Bloom, Griffith et al. 2002). Since 1987 M&E can be deducted in the year it is incurred and B&S at 4% on a declining balance basis.

CIT: 46% (1980-86), 45.5% (1987), 41.5% (1988), 38% (1989-2002), 33% (2003), 31% (2004-06).

The headline central government (CG) Corporate Income Tax is applied.[29] In Canada, the CG CIT is generally reduced by 10% (Provincial abatement) but increased by provincial (sub national) CIT. For example, the state CIT in Ontario has ranged from 12.5 to13%. Additional features include the rebate for the manufacturing sector that has varied from 2 to 7% as well as a federal surcharge which has varied from 0-5% over the period. The headline CG CIT is close to measures taking into account these additional factors that require additional assumptions.

Czech Republic

Incentives: Czech Republic was created in 1993. No special concessions were available between 1993 and 2005. As of 2005 a 200% deduction is available to all firms.

Depreciation: 5 years SL for M&E and 30 years SL for B&S applied over the entire period.

CIT: 45% (1993), 42% (1994), 41% (1995), 39% (1996-97), 35% (1998-2000), 31% (2001-03), 28% (2004), 26% (2005), 24% (2006).

Denmark

Incentives: For the current series no special incentives are modelled.

Denmark has had a range of concessions in place, but these have been attached to special conditions. These have been aimed at encouraging research collaboration both internationally and between tertiary research institutions and private business. For example, between 1988 and 1995, R&D associated with special international projects (EUREKA, ESPRIT, BARITE and RASE) was eligible for a 125% deduction (LawS.8G) (ETAN 1999a). As these were not available to all firms, they are not modelled here.

Since 2002, a 150% deduction has been available for current expenses related to basic research if undertaken in collaboration with the higher education sector.[30]

Depreciation: Between 1980-1997 all fixed assets are deducted 100% in the year of expense. For the period 1998- 2006 M&E and B&S are deducted according to a 30% declining balance (DB) and 20 year SL, respectively.

---

[29] The exception is that it appears that OECD (2007b) presents the CGCIT with the provincial tax abatement already accounted for in the years 2000-2006. This is re-added to be consistent with previous years.

[30] Several sources, e.g., Warda (2001) and others, apply a 125% deduction for 'fundamental' R&D for some of the years between 1995 and 2001. A European Commission report observes that this scheme (Law S. 8F). is: "expected to be operable in 1995" (ETAN 1999a). The IBFD website and IBFD (2004) suggests the 125% deduction is only available for projects approved *before* 1995; an additional 25% deduction for approved projects and also 25% on projects associated with international research projects noted above. Furthermore PWC (1999) lists the 125% deduction only associated with the nominated international projects (as in Law S.8G above). This concession is not modelled here.

CIT: 40% (1980-85), 50% (1986-89), 40% (1990), 38% (1991-92), 34% (1993-98), 32% (1999-2000), 30% (2001-04) and 28% (2005-06).

Finland

Incentives: Tax Deduction Enhancement 1983-87 allowed firms to deduct 225% on the first 4m FM (< $1 million USD) and 10% on amounts above this (ETAN 1999). In addition a 50% deduction was available on incremental expenditure above the previous year. It has been suggested that the scheme was ultimately withdrawn on the basis that little impact was observed (ETAN 1999a).

The calculations here apply the 10% rate on the volume plus the 50% incremental scheme to current expenditure between 1983 and 1987 inclusive.

Depreciation: 25% DB for M&E and 20% DB for B&S.

CIT: 43% (1980-85), 33% (1986-89), 25 (1990) 23% (1991), 19% (1992), 25 % (1993-1995), 28% (1996-1999), 29% (2000-04), 26% (2005-).

France

Incentives: For the years 1983-1984, (introduced Dec 1982) businesses in France could claim a 25% tax credit on expenditure above the previous year's expenditure (Mulkay and Mairesse 2003). Eligible expenditure is current and M&E. This was increased to 50% in 1985.

Between 1988-90 an alternative credit of 30% on the increment above expenditure in 1987 was available (Bloom, Griffith et al. 2002). This is modelled for 1989 and 1990 as this results in a larger subsidy in these years under the current assumptions.

In 1991, the base for calculating incremental expenditure was changed to be defined as the average of the previous two years (two year moving average) (Mulkay and Mairesse 2003). From 2004 to 2005, firms could claim 5% on volume and 45% on incremental expenditure with incremental expenditure defined as a 2 year moving average.

In 2006, this was again changed to 10% on the volume and 40% on incremental expenditure above a 2 year moving average.

Depreciation: M&E and B&S are depreciated at 4% DB and 20 years SL respectively. However, between 1983-1986 B&S used for scientific research attracted an accelerated depreciation under which 50% was deducted in the year of expense with the remainder deducted over the usual period (Bloom, Griffith et al. 2002).

CIT: 50% (1980-86), 45% (1987), 42% (1988), 39% (1989), 37% (1990), 34% (1991-92), 33% (1993-2006).

Germany

Incentives: Germany has had no special concessions in place since reunification.

Following Bloom et al. (2002) no incentive schemes are modelled for the former Federal Republic.[31]

Depreciation: Depreciation rates applied are 20% DB for M&E and 4% DB for B&S.

CIT: 61.8% (1980-1989), 59.7% (1990-1993), 55.6% (1994), 59.0% (1995-1996), 57.5%, (1997-98), 52.0% (1999-2000), 38.0% (2001-02), 40.0%, 38.0% (2004-06), 38.3% (2006).

CIT Data applied for Germany from 1990 is taken from KPMG which include both central government rate and important corporate income taxes that vary by municipality. KPMG do not cover 1990 and 1992, the 1993 figure is extrapolated back as the headline CGCIT is the same in each of these years. Prior to 1990 figures are taken directly from Bloom et al. (2002).

Greece

Incentives: Greece has had no special concessions available throughout this period.

Depreciation: Depreciation rates of 12.5 years (SL) for buildings.[32] For M&E immediate deduction is assumed for the period between 1980 and 1998 (consistent with Warda 1996b) and depreciation over 3 years (SL) for the period 1999 to 2006 (consistent with Warda 2001). The precise details for the change in treatment of M&E could not be confirmed from primary sources, however the difference in overall index measure is only at the fourth decimal place.

CIT: 43.4% (1980-1982), 48.5% (1983-84), 49.0% (1985-1988), 46.0% (1989-1992), 35.0% (1993-2004), 32.0% (2005), 29.0% (2006).

Hungary

Incentives: Hungary has had tax incentive for R&D in place since 1997.

For the period 1997-1999 current expenditure can be deducted at a rate of 120%. In 2000 this was increased to 200%.

Since 2004, there has also been a 400% deduction available if the R&D is in collaboration with university. As this is not available to all BERD it is not modelled here.

Depreciation: 3 years SL for M&E and 50 years SL for Buildings.

---

31 McFetridge and Warda (1983) cite that a 7.5% credit on R&D fixed assets was in place when they published their study. I could not find any further information about this, importantly when it ceased. Credits limited to capital expenditure have only a small effect on the policy measure based on the assumptions applied here.

32 Note this is consistent with several sources, however, (Warda 1996b) cites that buildings "would probably" be depreciated at 8% which gives a NPV very close to 12.5 years.

CIT: 40.0% (1990-1993), 36.0% (1994), 18.0% (1995-2003), 16.0% 2004-2006.

Information compiled from the Hungary National Office for Research and Technology website, NKTH (2006) and PWC (1999). CIT taken from WTD (2007) and KPMG (2007).

Ireland

Incentives: Between 1996 and 1998: a special 400% deduction was available on R&D expenditure above the previous year (ICSTI 1998; ETAN 1999a). Only companies eligible for the special 10% CIT were eligible (see below under CIT). The scheme had a relatively low cap (175,000 IEP or about 350,000 USD) and according to the Irish Council for Science, Technology & Innovation "the deduction still had many restrictions and was little used by either foreign or indigenous research performers." This scheme is modelled here, however, it can be noted that because of the low CIT, the scheme has a small impact on the cost of R&D.

The Finance Act 2004 introduced a 20% tax credit on the volume of expenditure on B&S and also on incremental current expenditure and investment in ME. The baseline for calculating incremental expenditure is 2003 for R&D expenditure incurred in the first 3 years of the scheme (2004 to 2006, inclusive). Thereafter, the base is defined as the expenditure four years previous. i.e., for 2007 the baseline will be 2004 and for 2008 the base will be 2005, and so on.

Depreciation: Both M&E and B&S are written off in the year it is incurred over the entire period.

CIT: Ireland introduced a special tax rate of 10% nominally for manufacturing companies in 1981. In practice, eligibility extended to most relevant firms as courts deemed businesses in a number of activities not normally regarded as manufacturing as being eligible (Lowtax.net 2008). This is the rate applied in most past studies of tax concessions. In 1980 CIT was the standard 45%.

Italy

Incentives: Italy had no special tax treatment for R&D by large firms during the period of study. A 30% tax credit for small businesses only was introduced in 1992, which is not modelled here.

Depreciation: 10 years (SL) for M&E and 33 years (SL) for buildings.

CIT: 36.3% (1980-1981), 38.8% (1982), 41.3% (1983), 46.4% (1984-1990), 47.8% (1991-1992), 52.2% (1993-1998), 41.3% (1998-2000), 40.3% (2001-2002), 38.3% (2003), 37.3% (2004-2006).

Italy has local income tax which has ranged in magnitude from 15% to 30% (deductible from central government rate). This tax was replaced with the Regional Tax on Productive Activities

(IRAP) in 1998. The CIT data series in the current study is taken from KPMG (2007) for the years 1993-2006. Prior to 1993, the data is taken from Bloom et al. (2002)

Japan

Incentives: Japan has had a tax incentive for R&D in place since 1967 (Koga 2003). For the period 1980 to 1998 a 20% tax credit on incremental expenditure, with the base defined as the largest expenditure reported since 1967, which for the representative firm is the previous year's expenditure.[33] Current and M&E expenditure are eligible to receive the credit and the scheme is subject to a maximum cap of 10% of a companies CIT liabilities. [34]

Reform in April 1999 (Koga 2003) reduced the rate to 15% and the definition of the base was changed. From 1999 the base is as the average of the three maximum R&D expenses in the past 5 years. When calculating the average effective subsidy for a representative firm, the calculation amounts to assuming a 3 year moving average base.

From 2004, a credit is available on all R&D expenditure. The rate of the credit is 8-10% (depending on firm R&D intensity) plus an additional 2% "as an aid of overcoming depressed economic situation" (OECD 2006). The average 11% total tax credit is applied here.

Depreciation: 50 years SL for buildings[35] and for M&E. A depreciation schedule of 18% DB for M&E for the years 1980-2003, and 50% thereafter is applied here.[36]

CIT: Three forms of taxation levied on corporate profits in Japan are considered: central government rate, prefectural tax and citizens tax. Corporations operating in Japan must also pay prefectural tax. The prefectural tax rate in this study is taken as 12% (deductible). The inhabitants tax or enterprise tax is levied as a "surcharge on national income tax." In this study, Warda (1996b) is followed, applying a rate of 20.7%. Central government rate is taken from the WTD. The eventual series is very close to the Composite CIT reported by KPMG that takes into account these sub-national taxes. However this enabled calculation of an equivalent figure for years that are not included in the KPMG database (1980-1992). There was also a different tax rate applied to retained and distributed profits prior to 1999 this is not modelled here.

The final series is given by: 53.0% (1980), 55.2% (1981-1983), 56.6% (1984-1986), 55.2% (1987-1988), 53.0% (1989), 50.4% (1990-1997), 47.2% (1998), 42.4% (1999-2006).

---

33 If a firm's current expenditure is equal to or above its previous maximum this is equivalent to the marginal credit.
34 Other special credits with limited availability have been available including a 5% credit limited to depreciable assets used in 'basic' research and others limited to small firms (Sawyer 2005). These are not modelled here.
35 This is based on (Warda 1996b) and is also consistent with available figures for b-index published by the OECD.
36 McFetridge and Warda (1983) suggests this is depreciated "over useful life 4-7 years. - This is close NPV to the 18% DB applied for later periods.

Korea

Incentives: An incentive introduced in 1988 allowed firms to claim a credit of 25% on incremental expenditure above a 2 year moving average base and 5% on the volume of current expenditure (10% on volume for small firms) (OECD 1998 p.172).

Between 1998[37] and 2004 companies could choose between either the 50% on incremental expenditure or 5% on the total volume of expenditure. The 50% incremental rate is applied here as it is the more generous of the two under the current assumptions. The reforms also changed the base to the average of the previous four years (OECD 2000b; Sawyer 2004). It also appears that the depreciation rates of B&S used for R&D became 5 years SL. The rate of the incremental scheme was reduced from 50 to 40% in 2003 (Rashkin 2007). In addition a 5% credit on expenditure on fixed assets is modelled (Sawyer 2004). None of the credits reduced standard expense deductions (i.e., they are untaxed).

Deprecation: Between 1980 and 1997 depreciation rates of 22.6% and 5.6% DB are applied for M&E and B&S respectively.[38] For the subsequent decade each are depreciated over 5 years on a SL basis (Warda 1999 and subsequent OECD documents).

CIT: 30.0% (1980-1990), 34.0% (1991-1993), 32.0% (1994), 30.0% (1995), 28.0% (1996-2001), 27.0% (2002), 25.0% (2005).

Mexico

Incentives: Between 1981 and 1982 (introduced November 1980) Mexico provided a tax credit on durables of 15-20% (McFetridge and Warda 1983). The maximum 20% rate is applied here. There was also a credit of 10% for payment for 'R&D services'. These represent contract R&D or outsourcing part of the R&D process. Warda (1983) suggests such expenditure comprises around 8% of total R&D spending.

Between 1983 and 1996 no special incentives were generally available.

Between 1997 and 2001 current R&D expenditures, above a three year moving average were eligible for a 20% credit (Sawyer 2004).

Since 2002 a 30% credit has been available on the volume of current R&D expenditure (OECD 2006) .

Credits are untaxed; i.e., they do not reduce standard deductions.

---

37 Associated with the 'Special Law for S&T' enacted in 1997

38 This is consistent with Warda (1996b) and others. However, Warda (1983) notes 50% of these assets are depreciated up front with the remainder depreciated "over their useful lives". In the absence of further guidance, the 1996 information on asset deprecation has been applied back to 1980.

Depreciation: The depreciation rates applied are 3 and 20 years on a SL basis for M&E and B&S, respectively.

CIT: 42.0% (1980-1986), 35.0% (1987-88), 37.0% (1989), 36.0% (1990), 35.0% (1991-1993), 34.0% (1994-1998), 35.0% (1999-2002), 34.0% (2003), 33.0% (2004), 30.0% (2005), 29.0% (2006).

Netherlands

Incentives: Netherlands represents an important case study for the effectiveness of R&D tax incentives. From 1994,[39] R&D wages attracted a tax credit of 40% of the first 72,000 ECU and 12.5% of above (Hall 1995b). The 12.5 rate is modelled. This credit applies to salaries and these are assumed to constitute 60% of total representative R&D expenditure. The value of the concession increased to 13% in 2001 and to 14% from 2004.

Additional special provisions for small firms only were introduced in 2001. These are not modelled here.

Depreciation: Depreciation rates applied are 5 and 25 years on a SL basis for M&E and B&S, respectively.

CIT: 48.0% (1980-1983), 43.0% (1984-85), 42.0% (1986-88), 35.0% (1989-1995), 37.0% (1996), 36.0% (1997), 35.0% (1998-2001), 34.5% (2002-2004), 31.5% (2005), 29.6% (2006).

New Zealand.

Incentives: No special concessions or tax credits have been available during the period 1980-2005.

Depreciation: The rules for deducting 'current' R&D expenditure have been subject to some uncertainty, particularly prior to 2001. Generally, firms were required to amortise R&D costs in as much as they are 'capital in nature' – i.e., that the activities bring "into existence an asset for the enduring benefit of the business" (IRD 2000). Factors which influence the deductibility of expenses include the presence of uncertainty and risk, and also whether the expense is ongoing or one off.

Reforms in 2001 clarified the situation somewhat. Under these changes deductibility is based on Accounting Standard FRS-13 which distinguishes between research (deductible) and development (not deductible). Sawyer (2005) observes that there is a "relatively high threshold

---

[39] OECD figures made available by Martin Falk, appear to show the schemes introduction in 1995. The year of introduction used here follows the Netherlands Ministry of Economic Affairs (Dorsman 1997) and (Hall 1995b)

before a cost needs to be capitalised" (ibid: p.3), one important criteria being proven technical feasibility; i.e., projects undertaken in the face of appreciable technical risk are fully deductible.

While the situation prior to 2001 was somewhat ambiguous, a discussion paper prepared by the New Zealand Inland Revenue Department observes that "…although the tax treatment of R&D expenditure is uncertain, taxpayers are immediately deducting almost all of their R&D costs" (IRD 2000). Separate provisions (DJ 9 ITA 1994 and earlier s 144 ITA 1976) existed, allowing deductions for expenditure relating to scientific research. Provisions under ITA 1976 suggest a similar capital test.

The series employed here assumes 100% deductibility for current expenditure for all periods.[40]

Depreciation: Following Warda (2006) a representative depreciation schedule of 22% (DB) is applied for M&E, and 4% (DB) for B&S.

CIT: 45.0% (1980-1985), 48.0% (1987-88), 28.0% (1989), 33.0% (1990-2006).

Norway

Incentives: 1980-2001 no special concessions.

2002 – current 18% tax credit available on current R&D expenditures (OECD 2006).

Depreciation: M&E and B&S depreciated at 20% and 5% (DB) respectively.

CIT: 50.8% (1980-1991), 28.0% (1992-2006).

Before the reform in 1992, basic CIT in Norway was 27.8% as cited in WTD. Corporations also paid municipal income tax (21% in 1989) and an additional 2% surtax (Genser 2001). McFetridge and Warda (1983) also cite the total rate as 51%.

Poland

Incentives: From July 2005,[41] large firms receive a 30% tax credit on expenditure "incurred to purchase new technologies" (IBFD online database). Accessibility is limited to firms which obtain at least 50% of their income from R&D, the law "enables entrepreneurs to deduct from their tax base expenditures on purchase of new technologies from research units" (OECD 2006 p.71). As such, it appears this incentive is not available for all 'in house' R&D. The purchase of R&D services is assumed to constitute 8% of R&D costs - analogously to the scheme in Mexico in 1980-82 (discussed above).

---

[40] It appears some previous estimates are based on assuming expenditure is amortised. While this issues is a fundamental source of ambiguity, based on the evidence presented above I assume the standard 90% of expenditure is written off immediately.

[41] IBFD online database states that this came into effect in 2006, whereas the OECD (2006 p.71) suggests July 2005.

Depreciation: prior to the 2005 reform, in principle, successful R&D expenditure is classified as an intangible asset and had to be depreciated over 3 years on a straight line basis (IBFD 2004). M&E and B&S did not attract any special treatment and are depreciated over 4 years and 40 years, respectively (IBFD online database 2007). After the reform in 2005 'current' R&D are expensed.

CIT: 40.0% (1991-1997), 36.0% (1998), 34.0% (1999), 28.0% (2000-2002), 27.0% (2003), 19.0% (2004-2006).

Portugal

Incentives: From 1997 to 2000, current R&D expenditure attracted a tax credit of 8% on the volume and 30% on incremental expenditure above the average expenditure in the previous 3 years (EC 2002).[42].

In June 2001 the credit was increased to 20% on volume and 50% on incremental expenditure (Decree law no 197/2001). It understood that the base changed to a 2 year moving average (OECD 2002b).

2004 – No scheme in place (OECD 2006).

From 2004 expenditure attracts a tax credit 20% on volume and 50% on incremental expenditure (IBFD online database).

Depreciation: Depreciation schedule of 4 and 20 years (SL) for M&E and B&S, respectively is applied (consistent with Warda 1996b and others).[43]

CIT: 23.0% (1980-81), 40.0% (1982-1986), 35.0% (1987-88), 36.5% (1989-90), 36.0% (1991-1997), 37.0% (1998), 34.0% (1999), 32.0% (2000-01), 30.0% (2002-03), 25.0% (2004-06).

WTD (2007) series show jumps in CIT to 39.6% in 1995 and 1997. These appear to be the sum of the 36% base tax rate and the 10% local surcharge. A rate of 36% is applied in these years.

Spain

Information for Spain was provided by J. Warda (personal communication). This is consistent with available OECD figures[44]

---

[42] Decree law no 292/97, and prolonged to cover 2001, 2002 and 2003 by Article 60 of Law no 3-B/2000.

[43] Note Warda (1983) applies 3 years for M&E however without knowing the exact year the laws were changed, or if this results from alternate interpretation of the same depreciation guidelines, to avoid erroneous temporal variation the same rate is applied across the whole time.

[44] There is some discrepancy in the treatment of Spain between sources. The calculations applied here area also consistent with EC (2002). However, Bloom et al. (2002) suggest that "up to and including 1989, Spain applied the same rules for R&D as for any new assets. These included investment tax credits for all new fixed assets of 10%

Incentives: 1981-83 10% credit on all expenditure. Between1984-1991, a credit of 15% was available on total current expenditure and 30% on investment in fixed assets (ME & B&S). 1992-95, current expenditure attracted a 15% credit on volume and 30% on incremental expenditure above a 2 year moving average. Over this time, fixed assets (ME and B) attracted a 30 % credit on volume and 45% on incremental expenditure.

1996-2000, 20% credit on volume and 40% on incremental expenditure (applicable to C and ME). Between 2001 and 2006, only current expenditure was eligible for the credit at a rate of 30% of volume and 50% on increment above the 3 year moving average.

Depreciation: M&E costs are expensed, B&S 7 years SL 1980-1995, 10 years 1996 and 33 years 1997-2006.

CIT: 33% (1980-1983), 35% (1984-2006).

Sweden

Incentives: 1980-1983 Special Deduction allowances of 10 % on wage payments grossed up by two thirds. i.e. 16.7% total wage payments (Warda 1983). In addition, a 20% deduction was available on the increment on the previous year's expenditure (wages). Effective 1 Jan 1982, the base credit was reduced from 10% to 5% applied to 250% of wages, implying a 12.5% concession on wages (i.e., 112% of wage costs are deducted). With this change the incremental component was also increased to 30%.

No other special concession at other times.

Depreciation: Depreciation rates 30% DB for M&E with B&S over 25 years SL.

CIT: 40.0% (1980-1983), 32.0% (1984), 52.0% (1985-1989), 40.0% (1990), 30.0% (1991-1993), 28.0% (1994-2006).

Switzerland

Incentives: Switzerland offered no special concession over the period covered by this study.

Depreciation: Representative depreciation schedules applied are 40% and 8% (DB) for M&E and B&S respectively.

CIT: 30.2% (1980-1989), 28.5% (1990-1997), 27.5% (1998), 25.1% (1999-2000), 24.7% (2001), 24.5% (2002), 24.1% (2003-04), 21.3% (2005-06)

(1983, 1988-89) 12% (1984) & 15% 1985-1987". 1990- 1995 15% credit (current) and 30% on fixed assets (ME & B).

Switzerland CIT should consider the effect of the cantonal tax rate for Zurich. For 1993-2005, KMPG data is used. KPMG report a jump of 5pp to 29% for 2006, however the OECD tax database series suggests no change between 2005 and 2006. Prior to 1993, the CIT is calculated based on the CG rate from WTD and adding the last known cantonal rate (18.5 pp, inferred from the difference between WTD and KPMG and constant for the period 1993-1997).

United Kingdom

Incentives: 1980-2000 no special concessions.

From 2000, 125% deduction on current expenditure is available for small companies with a turnover below 25m GBP. This is not modelled. From 1 April 2002, a similar concession was introduced for large firms of 125% deduction for current expenditure (IBFD 2007).

Depreciation: Both M&E and B&S are deducted in the year of expense.

CIT: 52.0% (1980-1983), 50.0% (1984), 45.0% (1985), 40.0% (1986), 35.0% (1987-1991), 33.0% (1992-1997), 31.0% (1998-1999), 30.0% (2000-2006).

United States

Tax Incentives: From 1981-1985 a 25% tax credit was available on incremental expenditure. The base is defined as the average of the previous three years with a maximum allowable credit of 50% of total R&D expenditure. In 1986, the credit is reduced to 20% of incremental expenditure. Until 1988, the credit itself was untaxed. In 1989 it was 50% taxable and from 1990 onwards it is 100% taxable. In 1990, the definition of the base expenditure was changed to reflect R&D to sales revenue over the period of 1984-88 (see Hall 1995b). That is, after 1990, the credit was paid on expenditure above a base level defined as (JCT 1997):

$$\frac{\text{Average R \& D over the period (1984 - 1988)}}{\text{Average sales revenue (1984 - 1988)}} \times \text{Average Sales in preceding 4 years.}$$

Defining the base in this way introduces a complexity in modelling the effective value of the credit. First, consider the case that the firm does not spend more than twice the base, which is consistent with the stated assumption of constant real expenditure with a 10% discount rate. The average after tax price R&D for a representative firm with constant R&D expenditure and constant real R&D/sales ratio is exactly equivalent to that under an incremental scheme with a trailing 4 year moving average base (i.e., the nominal value of constant real sales over the past 4 years). The marginal effective credit is the full 20% under the assumption that a firm's expenditure is less than twice the base. This is because firms do not need to take into account the effect of current spending on the future value of the scheme

Alternatively, in the case that the firm spends more than the twice the base, the marginal and average effective credit are identical. The average effective credit is 10% (i.e., half of the 20% credit) and each extra dollar spent attracts an identical subsidy to the previous dollar.

Some OECD figures appear to be calculated assuming the maximum allowable claim of 50% of all current expenditure. However, here the scheme is modelled as the average effective subsidy assuming the firm does not spend more than twice the base, which is consistent with what is predicted for a representative firm. This method also results in a more reasonable estimate of the average rate of subsidy than assuming maximum possible credit. It can also be observed that the average rate of subsidy that is implied by the dividing the cost of the scheme by all BERD in the United States in 2004 is 2.3%. The rate implied by the method applied here is 1.3% whereas using the maximum possible subsidy method suggests 6.6%.

There are other aspects of eligibility that will reduce the power of the incentive that, while not modelled here, contribute to justify the lower figure. For example, foreign income allocation rules limit applicability of tax concessions to R&D directed to foreign sales which serves to further reduce the incentive power of the scheme, particularly for MNEs (see Hines and Jaffe, 2001 and Hall, 1995 for discussion). Finally, companies which pay the alternative minimum tax limit cannot benefit from the R&D tax credit (Hall 1995b).

Depreciation: applied is 5 years SL for M&E and for Buildings: 15yrs SL (1980-1984), 18yrs SL (1985), 19yrs SL (1986) and 39 years thereafter. The method for calculating depreciation was changed from 1987 with the introduction of the Modified Accelerated Cost Recovery System.

CIT: 46.0% (1980-86), 40.0% (1987), 34.0% (1988-1992), 35.0% (1993-2006).

11. Summary

Tax treatment of R&D differs between countries, particularly in regards to the design and implementation of incentives for R&D. To compare between countries and between years the standard b-index methodology is based on the average effective subsidy for a representative firm. Based on the information presented in the preceding section, b-index has been calculated for each country for each year possible. These are reported in Table 7

Table 7 B-index for OECD Countries 1980-2006

yr	*AUS*	*AUT*	*BEL*	*CAN*	*CHE*	*CZE*	*DNK*	*ESP*	*FIN*	*FRA*	*GBR*	*GER*	*GRC*
1980	1.01	0.95	0.98	0.83	1.01	.	1.00	0.86	1.02	1.03	1.00	1.07	1.02
1981	1.01	0.95	1.02	0.83	1.01	.	1.00	0.86	1.02	1.03	1.00	1.07	1.02
1982	1.01	0.95	1.02	0.83	1.01	.	1.00	0.86	1.02	1.03	1.00	1.07	1.02
1983	1.01	0.95	1.02	0.81	1.01	.	1.00	0.86	0.93	0.98	1.00	1.07	1.02
1984	1.01	0.99	1.02	0.81	1.01	.	1.00	0.75	0.93	0.98	1.00	1.07	1.02
1985	0.59	0.99	1.02	0.81	1.01	.	1.00	0.75	0.93	0.93	1.00	1.07	1.02
1986	0.59	0.99	1.02	0.81	1.01	.	1.00	0.75	0.95	0.93	1.00	1.07	1.02

1987	0.59	0.99	1.02	0.81	1.01	.	1.00	0.75	0.95	0.95	1.00	1.07	1.02
1988	0.59	0.99	1.02	0.83	1.01	.	1.00	0.75	1.01	0.95	1.00	1.07	1.02
1989	0.72	1.00	1.02	0.83	1.01	.	1.00	0.75	1.01	0.94	1.00	1.07	1.02
1990	0.72	1.00	1.01	0.83	1.01	.	1.00	0.75	1.01	0.91	1.00	1.06	1.02
1991	0.72	1.00	1.01	0.83	1.01	.	1.00	0.75	1.01	0.92	1.00	1.06	1.02
1992	0.72	0.94	1.01	0.83	1.01	1.03	1.00	0.72	1.01	0.92	1.00	1.06	1.02
1993	0.72	0.94	1.01	0.83	1.01	1.03	1.00	0.72	1.01	0.92	1.00	1.06	1.01
1994	0.79	0.93	1.01	0.83	1.01	1.03	1.00	0.72	1.01	0.92	1.00	1.05	1.01
1995	0.79	0.93	1.01	0.83	1.01	1.03	1.00	0.72	1.01	0.92	1.00	1.06	1.01
1996	0.89	0.93	1.01	0.83	1.01	1.03	1.00	0.68	1.01	0.92	1.00	1.06	1.01
1997	0.89	0.93	1.01	0.83	1.01	1.03	1.00	0.69	1.01	0.92	1.00	1.06	1.01
1998	0.89	0.93	1.01	0.83	1.01	1.02	1.02	0.69	1.01	0.92	1.00	1.06	1.01
1999	0.89	0.93	1.01	0.83	1.01	1.02	1.02	0.69	1.01	0.92	1.00	1.05	1.01
2000	0.90	0.89	1.01	0.83	1.01	1.02	1.02	0.69	1.01	0.92	1.00	1.05	1.01
2001	0.88	0.89	1.01	0.83	1.01	1.02	1.02	0.57	1.01	0.92	0.90	1.03	1.01
2002	0.88	0.89	1.01	0.83	1.01	1.02	1.02	0.57	1.01	0.92	0.90	1.03	1.01
2003	0.88	0.89	1.01	0.83	1.01	1.02	1.02	0.57	1.01	0.92	0.90	1.03	1.01
2004	0.88	0.89	1.01	0.83	1.01	1.02	1.02	0.57	1.01	0.86	0.90	1.03	1.01
2005	0.88	0.92	1.01	0.83	1.01	0.70	1.01	0.57	1.01	0.86	0.90	1.03	1.01
2006	0.88	0.92	1.01	0.83	1.01	0.73	1.01	0.57	1.01	0.80	0.90	1.03	1.01

Table 8 (cont) B-index for OECD Countries 1980-2006

yr	*HUN*	*IRL*	*ITA*	*JPN*	*KOR*	*MEX*	*NLD*	*NOR*	*NZL*	*POL*	*PRT*	*SWE*	*USA*
1980	.	1.00	1.03	1.02	1.02	1.02	1.04	1.05	1.04	.	1.01	0.95	1.03
1981	.	1.00	1.03	1.03	1.02	0.97	1.04	1.05	1.04	.	1.01	0.95	0.96
1982	.	1.00	1.03	1.03	1.02	0.97	1.04	1.05	1.04	.	1.02	0.97	0.96
1983	.	1.00	1.04	1.03	1.02	1.02	1.04	1.05	1.04	.	1.02	0.97	0.96
1984	.	1.00	1.04	1.03	1.02	1.02	1.03	1.05	1.04	.	1.02	1.02	0.96
1985	.	1.00	1.04	1.03	1.02	1.02	1.03	1.05	1.04	.	1.02	1.04	0.96
1986	.	1.00	1.04	1.03	1.02	1.02	1.03	1.05	1.04	.	1.02	1.04	0.97
1987	.	1.00	1.04	1.03	1.02	1.02	1.03	1.05	1.04	.	1.02	1.04	0.98
1988	.	1.00	1.04	1.03	0.91	1.02	1.03	1.05	1.04	.	1.02	1.04	0.98
1989	.	1.00	1.04	1.02	0.91	1.02	1.02	1.05	1.02	.	1.02	1.04	0.99
1990	1.03	1.00	1.04	1.02	0.91	1.02	1.02	1.05	1.02	.	1.02	1.03	0.99
1991	1.03	1.00	1.05	1.02	0.91	1.02	1.02	1.05	1.02	1.08	1.02	1.02	0.99
1992	1.03	1.00	1.05	1.02	0.91	1.02	1.02	1.02	1.02	1.08	1.02	1.02	0.99
1993	1.03	1.00	1.06	1.02	0.91	1.02	1.02	1.02	1.02	1.08	1.02	1.02	0.99
1994	1.02	1.00	1.06	1.02	0.91	1.02	0.91	1.02	1.02	1.08	1.02	1.02	0.99
1995	1.01	1.00	1.06	1.02	0.91	1.02	0.91	1.02	1.02	1.08	1.02	1.02	1.02
1996	1.01	0.97	1.06	1.02	0.91	1.02	0.90	1.02	1.02	1.08	1.02	1.02	0.99
1997	0.97	0.97	1.06	1.02	0.91	0.97	0.90	1.02	1.02	1.08	0.85	1.02	0.99
1998	0.97	0.97	1.04	1.02	0.91	0.97	0.91	1.02	1.02	1.07	0.85	1.02	0.99
1999	0.97	1.00	1.04	1.00	0.91	0.97	0.91	1.02	1.02	1.06	0.86	1.02	0.99
2000	0.81	1.00	1.04	1.00	0.91	0.97	0.91	1.02	1.02	1.05	0.86	1.02	0.99
2001	0.81	1.00	1.03	1.00	0.91	0.97	0.91	1.02	1.02	1.05	0.70	1.02	0.99
2002	0.81	1.00	1.03	1.00	0.91	0.97	0.90	0.79	1.02	1.05	0.71	1.02	0.99
2003	0.81	1.00	1.03	1.00	0.93	0.61	0.90	0.79	1.02	1.05	0.71	1.02	0.99
2004	0.84	0.97	1.03	0.85	0.93	0.61	0.89	0.79	1.02	1.03	1.01	1.02	0.99
2005	0.84	0.95	1.03	0.85	0.93	0.63	0.90	0.79	1.02	0.98	0.72	1.02	0.99
2006	0.84	0.94	1.03	0.85	0.93	0.63	0.90	0.79	1.02	0.98	0.72	1.02	0.99

Appendix B Additional Data Notes

As indicated at Figure 4, the data for Ireland prior to 1996 reported by the BEA appears inconsistent with the data reported by the OECD (2007a). Specifically, according to the BEA data US MNE's performed more R&D than the total Business R&D performed in Ireland reported by the OECD (2007a). This was not found to be the case in any other country in the sample except for Ireland.

The anomalous data is depicted in Table 9. Column (I) shows total BERD from the OECD MSTI series (OECD 2007a) and column (II) shows R&D reported by affiliates of US MNEs in manufacturing from the BEA (various years). Each series is expressed in current USD with a base year 2000.[45] Observe that in the years 1990, 1992 and 1994 affiliates of US MNEs report having performed more R&D in Ireland than the OECD reports was conducted in the country in total. For comparative purposes available data from OECD on total R&D performed by MNE affiliates are reported in column (III). Note that the BEA figures are also larger than these in the same years.

Table 9 Complete Data for Ireland BERD and Foreign R&D

year	(I) BERD (MSTI)	(II) US MNEs (BEA)	(III) All Foreign Affiliates (MSTI)
1981	102		
1982	105		
1983	106		
1984	129		
1985	150		
1986	166		102
1987	177		
1988	186		
1989	205		
1990	238	654	
1991	288		
1992	338	764	
1993	411		272
1994	476	482	
1995	535	166	354
1996	604		
1997	661		432
1998	708	376	
1999	762	246	486
2000	779	300	
2001	786	345	513
2002	826		
2003	898	340	647
2004	966	504	
2005	1,024	423	720

45 See appendix 4.1 for details of data construction

There is no obvious explanation for this anomaly. It can be noted that over this period, US firms purchased a larger stake of Irish industry and hence R&D capacity which suggests MNEs surveyed by the BEA may have reported capital outlays which would inflate this figure. However, the BEA survey form clearly states that R&D expenditure reported should "Include all costs incurred to support R&D, including R&D depreciation and overheads. Exclude capital expenditures" (BEA 2004 p.18 of the survey form)

Bibliography

ABS (1990-2006). Research and Experimental Development, Business Canberra, Australian Bureau of Statistics. **(Cat. 8104.0)**.

Aghion, P. and P. Howitt (1992). 'A Model of Growth Through Creative Destruction.' *Econometrica* **60**(2): 323-351.

Athukorala, P.-c. and A. Kohpaiboon (2006). Multinational Enterprises and Globalisation of R&D: A Study of U.S-based Firms, Research School of Pacific and Asian Studies Working Paper No. 2006/06. Australian National University, Canberra.

ATO (2002). R&D Tax Concession Information Sheet - "On own behalf " Provisions. Canberra, Australian Taxation Office.

BEA (2004). Annual Survey of US Investment Abroad U.S. Direct Investment Abroad: Final Results From the 1999 Benchmark Survey. . Washington, DC, Bureau of Economic Analysis**:** .

BEA (various years). Annual Survey of US Investment Abroad. Washington D.C., Bureau of Economic Analysis.

BIE (1993). Research Report 50. R&D, Innovation and Competitiveness: An Evaluation of the Research and Development Tax Concession. Canberra, Bureau of Industry Economics.

Bloom, N. and R. Griffith (2001). 'The Internationalisation of UK R&D.' *Fiscal Studies* **22**(3): 337-355.

Bloom, N., R. Griffith, et al. (2002). 'Do R&D Tax Credits Work? Evidence from a Panel of Countries 1979-1997.' *Journal of Public Economics* **85**(1): 1-31.

BLS (2008). Multifactor Productivity Trends, 2006, U.S. Bureau of Labour Statistics

Branstetter, L. (2003). Is Academic Science Driving a Surge in Industrial Innovation? Evidence from Patent Citations, Columbia Business School.

Branstetter, L., R. Fisman, et al. (2005). Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-Level Panel Data, NBER.

Branstetter, L. G., R. Fisman, et al. (2006). 'Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U. S. Firm-Level Panel Data.' *Quarterly Journal of Economics* **121**(1): 321-349.

Canadian Embassy Berlin (2003). A Summary of R&D Tax Incentives in Canada, availible at: http://www.infoexport.gc.ca/science/documents/germanytaxcredit.pdf.

Cantwell, J. (1989). *Technological Innovation and Multinational Corporations*. Massachusetts, Basil Blackwell.

Cantwell, J. (1995). 'The Globalisation of Technology: What Remains of the Product Cycle Model.' *Cambridge Journal of Economics* **19**: 155-174.

Caves, R. E. (1996). *Multinational Enterprise and Economic Analysis*. New York, Cambridge University Press.

Coe, D. T. and E. Helpman (1995). 'International R-And-D Spillovers.' *European Economic Review* **39**(5): 859-887.

Dagenais, M., P. Mohnen, et al. (1997). Do Canadian Firms Respond to the Fiscal Incentives to Research and Development. Montreal, Centre Interuniversitaire de recherche en analyse des organisations (CIRANO). **Scientific Series**.

Dorsman, M. (1997). Chapter 8. Evaluation of Industrial R&D Support in the Netherlands: The Wage Tax and Social Insurance Allowances Act / R & D Allowance. *Policy Evaluation in Innovation and Technology: Towards Best Practices*. Paris, OECD.

DTT (2008). France Tax Alert: Private Letter Ruling Confirms Applicability of R&D Tax Credit. France, Deloitte Touche Tohmatsu.

Dunning, J. H. (1988a). 'The Eclectic Paradigm Of International Production - A Restatement And Some Possible Extensions.' *Journal Of International Business Studies* **19**(1): 1-31.

Dunning, J. H. (1988b). 'The Eclectic Paradigm of International Production: an Update and Reply to its Critics.' *Journal of International Business Studies* **3**(1).
Dunning, J. H. (1994). 'Multinational Enterprises and Global Innovatory Capacity.' *Research Policy* **23**(1): 67-88.
EC (2002). Corporation Tax and Innovation: Issues at Stake and Review of European Union Experiences in the Nineties. Innovation Papers No. 19
European Commission
EC (2002). European Trend Chart on Innovation. Theme-specific Country Report: Portugal.
. http://cordis.europa.eu/en/home.html, European Commission, Community Research and Development Information Service
Eisner, R., Albert, Steven H., Sullivan, Martin A. (1984). 'The New Incremental Tax Credit for R&D: Incentive or Disincentive? 37(2), 171. .' *National Tax Journal* **37**(2): 171-184.
Engardio, P., B. Einhorn, et al. (2005). Outsourcing Innovation. *Business Week*. **March 21:** 84-.
ETAN (1999a). An International Compendium of Indirect Schemes and Measures for Supporting Research and Technological Development in Enterprises, European Commission, European Technology Assessment Network. **(http://www.cordis.lu/etan/src/topic-7.htm)**.
ETAN (1999b). An International Compendium of Indirect Schemes and Measures for Supporting Research and Technological Development in Enterprises. Supplementary Report, European Commission, European Technology Assessment Network. **(http://www.cordis.lu/etan/src/topic-7.htm)**.
Feldstein, M., J. R. Hines, et al., Eds. (1995). *The Effects of Taxation on Multinational Corporations*. National Bureau of Economic Research Project Report University of Chicago Press.
Gassler, H. and B. Nones (2008). 'Internationalisation of R&D and embeddedness: the case of Austria.' *Journal of Technology Transfer* **33**: 407-421.
Genser, B. (2001). Corporate Income Taxation In The European Union: Current State And Perspectives, Centre for Tax System Integrity Research School of Social Sciences Australian National University. **Working Paper No 17**.
Ginarte, J. C. and W. G. Park (1997). 'Determinants of patent rights: A cross-national study.' *Research Policy* **26**(3): 283-301.
Gregory, R. G. (1993). The Australian Innovation System, in R.R. Nelson (Ed), . *National Innovation Systems : a Comparative Analysis* New York, Oxford University Press: 324-352.
Grossman, G. M. and E. Helpman (1991). 'Quality Ladders In The Theory Of Growth.' *Review Of Economic Studies* **58**(1): 43-61.
Guellec, D. and B. V. Pottelsberghe (2000). The Impact of public R&D Expenditure on Business R&D. Paris, OECD. **STI Working Papers**.
Hall, B. H. (1992a). R&D Tax Policy During the Eighties: Success of Failure. Cambridge MA, NBER. **Working Paper No. 4240**.
Hall, B. H. (1995b). Effectiveness of Research and Experimentation Tax Credits: Critical Literature Review and Research Design, University of California Berkeley & NBER.
Hines, J. R. and A. Jaffe (2001). International Taxation and the Location of Inventive Activity. *International Taxation and Multinational Activty*. J. James R. Hines. Chicago, University of Chicago Press: 201-230.
Howells, J. (1997). Research and Technology Outsourcing. Manchester, Centre for Research on Innovation and Competition (CIRC) Discussion paper No. 6. **The University of Manchester**.
IBFD (2004). Tax Treatment of Research & Development Expenses, European Commission.
IBFD (2007). European Tax Surveys International Bureau of Fiscal Documentation. **(www.ibfd.org)**.
IBM (2008). The Enterprise of the Future: Global CEO study, IBM Corporation.
ICSTI (1998). Irish Council for Science Technology & Innovation. Task Force Report 1998. **(http://www.forfas.ie/icsti/statements/innent/task.htm)**.

IRC (2005). Revenue Guidelines for Research and Development Tax Credit, The Irish Revenue Commissioners. **(http://www.revenue.ie/pdf/research-dev.pdf)**.
IRD (2000). Research & Development Expenditure - Accounting Treatment for Tax Purposes. N. Z. Inland Revenue Department.
Jaffe, A. (1995). Comment on: Taxes, Technology Transfer, and the R&D Activities of Multinational Firms, in Martin Feldstein, James R. Hines Jr, and R. Glenn Hubbard (eds.),. *The Effects of Taxation on Multinational Corporations* University of Chicago Press.
JCT (1997). The Blue Book, General Explanation of Tax Legislation Enacted in 1997, U.S. Joint Committee on Taxation
Jones, C. I. and J. C. Williams (1998). 'Measuring the Social Return to R&D.' *Quarterly Journal Of Economics* **113**(4): 1119-1135.
Jorgenson, D. W. (1963). 'Capital Theory and Investment Behaviour.' *American Economic Review* **53**(2): 247-259.
Koga, T. (2003). 'Firm Size and R&D Tax Incentives.' *Technovation* **23**: 643-648.
KPMG (2007). KPMG Corporate Tax Rate Survey, KPMG.
Kumar, N. (1996). 'Intellectual Property Protection, Market Orientation and Location of Overseas R&D Activities by Multinational Enterprises.' *World Development* **24**(4): 673-688.
Kumar, N. (2001). 'Determinants of Location of Overseas R&D Activity of Multinational Enterprises: the Case of US and Japanese Corporations.' *Research Policy* **30**(1): 159-174.
Lall, S. (1979). 'The International Allocation of Research Activity by US Multinationals.' *Oxofrd Bulletin of Economics and Statistics* **41**(4): 313-331.
Lattimore, R. (1997). Research and Development Fiscal Incentives In Australia: Impacts and Policy Lessons. *Policy Evaluation in Innovation and Technology: Towards Best Practices*, OECD**:** 91-134.
Lichtenberg, F. R. (1992). R&D Investment and International Productivity Differences. **NBER Working Paper No. 4161**.
Lowtax.net (2008). Ireland Information: Business, Taxation and Offshore, http://www.lowtax.net/lowtax/html/jiroltr.html.
Lucas, R. E. (1988). 'On The Mechanics Of Economic-Development.' *Journal Of Monetary Economics* **22**(1): 3-42.
Mansfield, E. (1994). Intellectual Property Protection, Foreign Direct Investment and Technology Transfer,. Washington DC., International Finance Corporation **Discussion Paper 19**.
McAlpine, D. (2005). Tax Credits for R&D Investment, PricewaterhousCoopers, London. Availible at http://www.pwc.com/gx/eng/ins-sol/publ/ipvalue/Credits-RD-05.pdf.
McFetridge, D. G. and J. P. Warda (1983). *Canadian R&D Incentives: Their Adequacy and Impact, Canadian Tax Paper No. 70*. Toronto, Canadian Tax Foundation.
Mulkay, B. and J. Mairesse (2003). The Effect of the R&D Tax Credit in France.
.
National Science Board (2008). *Science and Engineering Indicators 2008*. . Arlington, VA, National Science Foundation
Nickell, S. (1981). 'Biases In Dynamic-Models With Fixed Effects.' *Econometrica* **49**(6): 1417-1426.
NKTH (2006). Hungarian Tax Incentives for Research and Development National Office for Research and Technology Hungary.
OECD (1996). *Fiscal Measures to Promote R&D and Innovation*. Paris, OECD.
OECD (1998). *Technology, Productivity and Job Creation. Best Policy Practices*. Paris, OECD.
OECD (1998b). *Internationalisation of Industrial R&D: Patterns and Trends*. Paris, OECD.
OECD (2000b). STI Outlook 2000: National Policies. Country Response, Korea, OECD.
OECD (2002a). *Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development*. Paris, OECD.
OECD (2002b). *Tax Incentives for Research and Development: Trends and Issues*. Paris, OECD.
OECD (2005a). *Innovation Policy and Performance a Cross Country Comparison*. Paris, OECD.
OECD (2005c). *OECD Handbook on Economic Globalisation Indicators*. Paris, OECD.

OECD (2006). *OECD Science, Technology and Industry Outlook 2006*. Paris, OECD.
OECD (2007a). *Main Science and Technology Indicators (MSTI): 2007/2 edition*, OECD.
OECD (2007b). *OECD Tax Database*. Paris, OECD.
Park, W. G. and J. C. Ginarte (1997). 'Intellectual property rights and economic growth.' *Contemporary Economic Policy* **15**(3): 51-61.
Pottelsberghe, B. v. (2008). Europe's R&D: Missing the Wrong Targets? Brussels Belgium, Bruegel Policy Brief. **2008/03**.
PWC (1999). PriceWaterHouse Coopers. *Doing Business in Denmark*.
PWC (1999). PriceWaterHouse Coopers. *Doing Business in Hungary*.
Rapp, R. T. and R. P. Rozek (1990). 'Benefits And Costs Of Intellectual Property Protection In Developing-Countries.' *Journal Of World Trade* **24**(5): 75-102.
Rashkin, M. D. (2007). *Practical Guide to Research and Development Tax Incentives. Federal, State and Foreign. 2nd Ed.* Chicago, Wolters Kluwer Business.
Romer, P. (1990). 'Endogenous Technological Change.' *Journal of Political Economy* **98**(5): S71-S102.
Roodman, D. (2006). How to Do xtabond2: An Introduction to "Difference" and "System" GMM in Stata, Center for Global Development.
Sawyer, A. J. (2004). Potential Implications of Providing Tax Incentives for Research and Development in NZ, Department of Accountancy, Finance and Information Systems, University of Canterbury Christchurch, NZ.
Sawyer, A. J. (2005). 'Reflections on Providing Tax Incentives for Research and Development: New Zealand at the Cross Roads.' *Journal of Australian Taxation* **8**(1): 111-149.
Thomas, D. W., T. S. Manly, et al. (2003). 'An International Investigation of the Influence of Dividend Taxation on Research and Development Tax Credits.' *The Journal of the American Taxation Association* **25**(2): 35-54.
UN (2005). *World Investment Report 2005: Transnational Corporations and the Internationalisation of R&D*. New York, United Nations.
Warda, J. (1996a). Measureing the Value of R&D Tax Provisions. *Fiscal Measures to Promote R&D and Innovation*. Paris, OECD.
Warda, J. (1996b). Background Paper for "Measuring the Value of R&D Tax Provisions", Provided by the Author.
Warda, J. (1999). Measuring the Attractiveness of R&D Tax Incentives: Canada and Major Industrial Countries, Statistics Canada, The Conference Board of Canada.
Warda, J. (2001). Measuring the Value of R&D Tax Treatment in OECD Countries *Science and technology Review No. 27*. Paris OECD. **27:** 185-211.
Warda, J. (2003). Extending Access to SR&ED Tax Credits: An International Comparitive Analysis, Information Technology Association of Canada**:** 22.
Warda, J. (2006). Tax Treatment of Business Investments in Intellectual Assets: An International Comparison. Paris, OECD. **STI Working Paper 2006/4**.
WB (2007). World Development Indicators, World Bank
Weder, R. and H. G. Grubel (1993). 'The New Growth Theory and Coasean Economics: Institutions to Capture Externalities.' *Weltwirtschaftliches Archiv*: 488-513.
WTD (2007). World Tax Database, University of Michigan

Working Papers in Trade and Development
List of Papers (including publication details as at 2009)

99/1 K K TANG, 'Property Markets and Policies in an Intertemporal General Equilibrium Model'.

99/2 HARYO ASWICAHYONO and HAL HILL, ''Perspiration' v/s 'Inspiration' in Asian Industrialization: Indonesia Before the Crisis'.

99/3 PETER G WARR, 'What Happened to Thailand?'.

99/4 DOMINIC WILSON, 'A Two-Sector Model of Trade and Growth'.

99/5 HAL HILL, 'Indonesia: The Strange and Sudden Death of a Tiger Economy'.

99/6 PREMA-CHANDRA ATHUKORALA and PETER G WARR, 'Vulnerability to a Currency Crisis: Lessons from the Asian Experience'.

99/7 PREMA-CHANDRA ATHUKORALA and SARATH RAJAPATIRANA, 'Liberalization and Industrial Transformation: Lessons from the Sri Lankan Experience'.

99/8 TUBAGUS FERIDHANUSETYAWAN, 'The Social Impact of the Indonesian Economic Crisis: What Do We Know?'

99/9 KELLY BIRD, 'Leading Firm Turnover in an Industrializing Economy: The Case of Indonesia'.

99/10 PREMA-CHANDRA ATHUKORALA, 'Agricultural Trade Liberalization in South Asia: From the Uruguay Round to the Millennium Round'.

99/11 ARMIDA S ALISJAHBANA, 'Does Demand for Children's Schooling Quantity and Quality in Indonesia Differ across Expenditure Classes?'

99/12 PREMA-CHANDRA ATHUKORALA, 'Manufactured Exports and Terms of Trade of Developing Countries: Evidence from Sri Lanka'.

00/01 HSIAO-CHUAN CHANG, 'Wage Differential, Trade, Productivity Growth and Education.'

00/02 PETER G WARR, 'Targeting Poverty.'

00/03 XIAOQIN FAN and PETER G WARR, 'Foreign Investment, Spillover Effects and the Technology Gap: Evidence from China.'

00/04 PETER G WARR, 'Macroeconomic Origins of the Korean Crisis.'

00/05 CHINNA A KANNAPIRAN, 'Inflation Targeting Policy in PNG: An Econometric Model Analysis.'

00/06 PREMA-CHANDRA ATHUKORALA, 'Capital Account Regimes, Crisis and Adjustment in Malaysia.'

00/07 CHANGMO AHN, 'The Monetary Policy in Australia: Inflation Targeting and Policy Reaction.'

00/08 PREMA-CHANDRA ATHUKORALA and HAL HILL, 'FDI and Host Country Development: The East Asian Experience.'

00/09 HAL HILL, 'East Timor: Development Policy Challenges for the World's Newest Nation.'

00/10 ADAM SZIRMAI, M P TIMMER and R VAN DER KAMP, 'Measuring Embodied Technological Change in Indonesian Textiles: The Core Machinery Approach.'

00/11 DAVID VINES and PETER WARR, ' Thailand's Investment-driven Boom and Crisis.'

01/01 RAGHBENDRA JHA and DEBA PRASAD RATH, 'On the Endogeneity of the Money Multiplier in India.'

01/02 RAGHBENDRA JHA and K V BHANU MURTHY, 'An Inverse Global Environmental Kuznets Curve.'

01/03 CHRIS MANNING, 'The East Asian Economic Crisis and Labour Migration: A Set-Back for International Economic Integration?'

01/04 MARDI DUNGEY and RENEE FRY, 'A Multi-Country Structural VAR Model.'

01/05 RAGHBENDRA JHA, 'Macroeconomics of Fiscal Policy in Developing Countries.'

01/06 ROBERT BREUNIG, 'Bias Correction for Inequality Measures: An application to China and Kenya.'

01/07 MEI WEN, 'Relocation and Agglomeration of Chinese Industry.'

01/08 ALEXANDRA SIDORENKO, 'Stochastic Model of Demand for Medical Care with Endogenous Labour Supply and Health Insurance.'

01/09 A SZIRMAI, M P TIMMER and R VAN DER KAMP, 'Measuring Embodied Technological Change in Indonesian Textiles: The Core Machinery Approach.'

01/10 GEORGE FANE and ROSS H MCLEOD, 'Banking Collapse and Restructuring in Indonesia, 1997-2001.'

01/11 HAL HILL, 'Technology and Innovation in Developing East Asia: An Interpretive Survey.'

01/12 PREMA-CHANDRA ATHUKORALA and KUNAL SEN, 'The Determinants of Private Saving in India.'

02/01 SIRIMAL ABEYRATNE, 'Economic Roots of Political Conflict: The Case of Sri Lanka.'

02/02 PRASANNA GAI, SIMON HAYES and HYUN SONG SHIN, 'Crisis Costs and Debtor Discipline: the efficacy of public policy in sovereign debt crises.'

02/03 RAGHBENDRA JHA, MANOJ PANDA and AJIT RANADE, 'An Asian Perspective on a World Environmental Organization.'

02/04 RAGHBENDRA JHA, 'Reducing Poverty and Inequality in India: Has Liberalization Helped?'

02/05 ARCHANUN KOHPAIBOON, 'Foreign Trade Regime and FDI-Growth Nexus: A Case Study of Thailand.'

02/06 ROSS H MCLEOD, 'Privatisation Failures in Indonesia.'

02/07 PREMA-CHANDRA ATHUKORALA, 'Malaysian Trade Policy and the 2001 WTO Trade Policy Review.'

02/08 M C BASRI and HAL HILL, 'Ideas, Interests and Oil Prices: The Political Economy of Trade Reform during Soeharto's Indonesia.'

02/09 RAGHBENDRA JHA, 'Innovative Sources of Development Finance – Global Cooperation in the 21st Century.'

02/10 ROSS H MCLEOD, 'Toward Improved Monetary Policy in Indonesia.'

03/01 MITSUHIRO HAYASHI, 'Development of SMEs in the Indonesian Economy.'

03/02 PREMA-CHANDRA ATHUKORALA and SARATH RAJAPATIRANA, 'Capital Inflows and the Real Exchange Rate: A Comparative Study of Asia and Latin America.'

03/03 PETER G WARR, 'Industrialisation, Trade Policy and Poverty Reduction: Evidence from Asia.'

03/04 PREMA-CHANDRA ATHUKORALA, 'FDI in Crisis and Recovery: Lessons from the 1997-98 Asian Crisis.'

03/05 ROSS H McLEOD, 'Dealing with Bank System Failure: Indonesia, 1997-2002.'

03/06 RAGHBENDRA JHA and RAGHAV GAIHA, 'Determinants of Undernutrition in Rural India.'

03/07 RAGHBENDRA JHA and JOHN WHALLEY, 'Migration and Pollution.'

03/08 RAGHBENDRA JHA and K V BHANU MURTHY, 'A Critique of the Environmental Sustainability Index.'

03/09 ROBERT J BAROO and JONG-WHA LEE, 'IMF Programs: Who Is Chosen and What Are the Effects?

03/10 ROSS H MCLEOD, 'After Soeharto: Prospects for reform and recovery in Indonesia.'

03/11 ROSS H MCLEOD, 'Rethinking vulnerability to currency crises: Comments on Athukorala and Warr.'

03/12 ROSS H MCLEOD, 'Equilibrium is good: Comments on Athukorala and Rajapatirana.'

03/13 PREMA-CHANDRA ATHUKORALA and SISIRA JAYASURIYA, 'Food Safety Issues, Trade and WTO Rules: A Developing Country Perspective.'

03/14 WARWICK J MCKIBBIN and PETER J WILCOXEN, 'Estimates of the Costs of Kyoto-Marrakesh Versus The McKibbin-Wilcoxen Blueprint.'

03/15 WARWICK J MCKIBBIN and DAVID VINES, 'Changes in Equity Risk Perceptions: Global Consequences and Policy Responses.'

03/16 JONG-WHA LEE and WARWICK J MCKIBBIN, 'Globalization and Disease: The Case of SARS.'

03/17 WARWICK J MCKIBBIN and WING THYE WOO, 'The consequences of China's WTO Accession on its Neighbors.'

03/18 MARDI DUNGEY, RENEE FRY and VANCE L MARTIN, 'Identification of Common and Idiosyncratic Shocks in Real Equity Prices: Australia, 1982 to 2002.'

03/19 VIJAY JOSHI, 'Financial Globalisation, Exchange Rates and Capital Controls in Developing Countries.'

03/20 ROBERT BREUNIG and ALISON STEGMAN, 'Testing for Regime Switching in Singaporean Business Cycles.'

03/21 PREMA-CHANDRA ATHUKORALA, 'Product Fragmentation and Trade Patterns in East Asia.'

04/01 ROSS H MCLEOD, 'Towards Improved Monetary Policy in Indonesia: Response to De Brouwer'

04/02 CHRIS MANNING and PRADIP PHATNAGAR, 'The Movement of Natural Persons in Southeast Asia: How Natural?

04/03 RAGHBENDRA JHA and K V BHANU MURTHY, 'A Consumption Based Human Development Index and The Global Environment Kuznets Curve'

04/04 PREMA-CHANDRA ATHUKORALA and SUPHAT SUPHACHALASAI, 'Post-crisis Export Performance in Thailand'

04/05 GEORGE FANE and MARTIN RICHARDSON, 'Capital gains, negative gearing and effective tax rates on income from rented houses in Australia'

04/06 PREMA-CHANDRA ATHUKORALA, 'Agricultural trade reforms in the Doha Round: a developing country perspective'

04/07 BAMBANG-HERU SANTOSA and HEATH McMICHAEL, ' Industrial development in East Java: A special case?'

04/08 CHRIS MANNING, 'Legislating for Labour Protection: Betting on the Weak or the Strong?'

05/01 RAGHBENDRA JHA, 'Alleviating Environmental Degradation in the Asia-Pacific Region: International cooperation and the role of issue-linkage'

05/02 RAGHBENDRA JHA, RAGHAV GAIHA and ANURAG SHARMA, 'Poverty Nutrition Trap in Rural India'

05/03 PETER WARR, 'Food Policy and Poverty in Indonesia: A General Equilibrium Analysis'

05/04 PETER WARR, 'Roads and Poverty in Rural Laos'

05/05 PREMA-CHANDRA ATHUKORALA and BUDY P RESOSUDARMO, 'The Indian Ocean Tsunami: Economic Impact, Disaster Management and Lessons'

05/06 PREMA-CHANDRA ATHUKORALA, 'Trade Policy Reforms and the Structure of Protection in Vietnam'

05/07 PREMA-CHANDRA ATHUKORALA and NOBUAKI YAMASHITA, 'Production Fragmentation and Trade Integration: East Asia in a Global Context'

05/08 ROSS H MCLEOD, 'Indonesia's New Deposit Guarantee Law'

05/09 KELLY BIRD and CHRIS MANNING, 'Minimum Wages and Poverty in a Developing Country: Simulations from Indonesia's Household Survey'

05/10 HAL HILL, 'The Malaysian Economy: Past Successes, Future Challenges'

05/11 ZAHARI ZEN, COLIN BARLOW and RIA GONDOWARSITO, 'Oil Palm in Indonesian Socio-Economic Improvement: A Review of Options'

05/12 MEI WEN, 'Foreign Direct Investment, Regional Geographical and Market Conditions, and Regional Development: A Panel Study on China'

06/01 JUTHATHIP JONGWANICH, 'Exchange Rate Regimes, Capital Account Opening and Real Exchange Rates: Evidence from Thailand'

06/02 ROSS H MCLEOD, 'Private Sector Lessons for Public Sector Reform in Indonesia'

06/03 PETER WARR, 'The Gregory Thesis Visits the Tropics'

06/04 MATT BENGE and GEORGE FANE, 'Adjustment Costs and the Neutrality of Income Taxes'

06/05 RAGHBENDRA JHA, 'Vulnerability and Natural Disasters in Fiji, Papua New Guinea, Vanuatu and the Kyrgyz Republic'

06/06 PREMA-CHANDRA ATHUKORALA and ARCHANUN KOHPAIBOON, 'Multinational Enterprises and Globalization of R&D: A Study of U.S-based Firms

06/07 SANTANU GUPTA and RAGHBENDRA JHA, 'Local Public Goods in a Democracy: Theory and Evidence from Rural India'

06/08 CHRIS MANNING and ALEXANDRA SIDORENKO, 'The Regulation of Professional Migration in ASEAN – Insights from the Health and IT Sectors'

06/09 PREMA-CHANDRA ATHUKORALA, 'Multinational Production Networks and the New Geo-economic Division of Labour in the Pacific Rim'

06/10 RAGHBENDRA JHA, RAGHAV GAIHA and ANURAG SHARMA, 'On Modelling Variety in Consumption Expenditure on Food'

06/11 PREMA-CHANDRA ATHUKORALA, 'Singapore and ASEAN in the New Regional Division of Labour'

06/12 ROSS H MCLEOD, 'Doing Business in Indonesia: Legal and Bureaucratic Constraints'

06/13 DIONISIUS NARJOKO and HAL HILL, 'Winners and Losers during a Deep Economic Crisis; Firm-level Evidence from Indonesian Manufacturing'

06/14 ARSENIO M BALISACAN, HAL HILL and SHARON FAYE A PIZA, 'Regional Development Dynamics and Decentralization in the Philippines: Ten Lessons from a 'Fast Starter''

07/01 KELLY BIRD, SANDY CUTHBERTSON and HAL HILL, 'Making Trade Policy in a New Democracy after a Deep Crisis: Indonesia

07/02 RAGHBENDRA JHA and T PALANIVEL, 'Resource Augmentation for Meeting the Millennium Development Goals in the Asia Pacific Region'

07/03 SATOSHI YAMAZAKI and BUDY P RESOSUDARMO, 'Does Sending Farmers Back to School have an Impact? A Spatial Econometric Approach'

07/04 PIERRE VAN DER ENG, 'De-industrialisation' and Colonial Rule: The Cotton Textile Industry in Indonesia, 1820-1941'

07/05 DJONI HARTONO and BUDY P RESOSUDARMO, 'The Economy-wide Impact of Controlling Energy Consumption in Indonesia: An Analysis Using a Social Accounting Matrix Framework'

07/06 W MAX CORDEN, 'The Asian Crisis: A Perspective after Ten Years'

07/07 PREMA-CHANDRA ATHUKORALA, 'The Malaysian Capital Controls: A Success Story?

07/08 PREMA-CHANDRA ATHUKORALA and SATISH CHAND, 'Tariff-Growth Nexus in the Australian Economy, 1870-2002: Is there a Paradox?,

07/09 ROD TYERS and IAN BAIN, 'Appreciating the *Renbimbi*'

07/10 PREMA-CHANDRA ATHUKORALA, 'The Rise of China and East Asian Export Performance: Is the Crowding-out Fear Warranted?

08/01 RAGHBENDRA JHA, RAGHAV GAIHA AND SHYLASHRI SHANKAR, 'National Rural Employment Guarantee Programme in India — A Review'

08/02 HAL HILL, BUDY RESOSUDARMO and YOGI VIDYATTAMA, 'Indonesia's Changing Economic Geography'

08/03 ROSS H McLEOD, 'The Soeharto Era: From Beginning to End'

08/04 PREMA-CHANDRA ATHUKORALA, 'China's Integration into Global Production Networks and its Implications for Export-led Growth Strategy in Other Countries in the Region'

08/05 RAGHBENDRA JHA, RAGHAV GAIHA and SHYLASHRI SHANKAR, 'National Rural Employment Guarantee Programme in Andhra Pradesh: Some Recent Evidence'

08/06 NOBUAKI YAMASHITA, 'The Impact of Production Fragmentation on Skill Upgrading: New Evidence from Japanese Manufacturing'

08/07 RAGHBENDRA JHA, TU DANG and KRISHNA LAL SHARMA, 'Vulnerability to Poverty in Fiji'

08/08 RAGHBENDRA JHA, TU DANG, ' Vulnerability to Poverty in Papua New Guinea'

08/09 RAGHBENDRA JHA, TU DANG and YUSUF TASHRIFOV, 'Economic Vulnerability and Poverty in Tajikistan'

08/10 RAGHBENDRA JHA and TU DANG, 'Vulnerability to Poverty in Select Central Asian Countries'

08/11 RAGHBENDRA JHA and TU DANG, 'Vulnerability and Poverty in Timor- Leste'

08/12 SAMBIT BHATTACHARYYA, STEVE DOWRICK and JANE GOLLEY, 'Institutions and Trade: Competitors or Complements in Economic Development?

08/13 SAMBIT BHATTACHARYYA, 'Trade Liberalizaton and Institutional Development'

08/14 SAMBIT BHATTACHARYYA, 'Unbundled Institutions, Human Capital and Growth'

08/15 SAMBIT BHATTACHARYYA, 'Institutions, Diseases and Economic Progress: A Unified Framework'

08/16 SAMBIT BHATTACHARYYA, 'Root causes of African Underdevelopment'

08/17 KELLY BIRD and HAL HILL, 'Philippine Economic Development: A Turning Point?'

08/18 HARYO ASWICAHYONO, DIONISIUS NARJOKO and HAL HILL, 'Industrialization after a Deep Economic Crisis: Indonesia'

08/19 PETER WARR, 'Poverty Reduction through Long-term Growth: The Thai Experience'

08/20 PIERRE VAN DER ENG, 'Labour-Intensive Industrialisation in Indonesia, 1930-1975: Output Trends and Government policies'

08/21 BUDY P RESOSUDARMO, CATUR SUGIYANTO and ARI KUNCORO, 'Livelihood Recovery after Natural Disasters and the Role of Aid: The Case of the 2006 Yogyakarta Earthquake'

08/22 PREMA-CHANDRA ATHUKORALA and NOBUAKI YAMASHITA, 'Global Production Sharing and US-China Trade Relations'

09/01 PIERRE VAN DER ENG, ' Total Factor Productivity and the Economic Growth in Indonesia'

09/02 SAMBIT BHATTACHARYYA and JEFFREY G WILLIAMSON, 'Commodity Price Shocks and the Australian Economy since Federation'

09/03 RUSSELL THOMSON, 'Tax Policy and the Globalisation of R & D'