

Government tax setting for mobile corporate income

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- Intangible capital account for growing share of inputs into production
- The income from intangible capital is highly mobile
- How we tax the income from intangible capital, in particular income from Intellectual Property, is a problem confronting many governments
- What impact do taxes on income from Intellectual Property have? What has been the impact of recent reforms in European countries?

Intangible capital accounts for growing share of inputs

- Intangible assets include:
 - research, development (R&D), design, intellectual property, software development, investments in training, organisational development, marketing and branding
- Since early 1990s investment in intangible assets has been greater than that in fixed (tangible) capital in UK
 - nominal investments in intangibles growing at more than double the rate of tangible investment since 2000
- OECD described growing significance of intellectual property and its simultaneous use by many different parts of a firm as “one of the most important commercial developments in recent decades.”

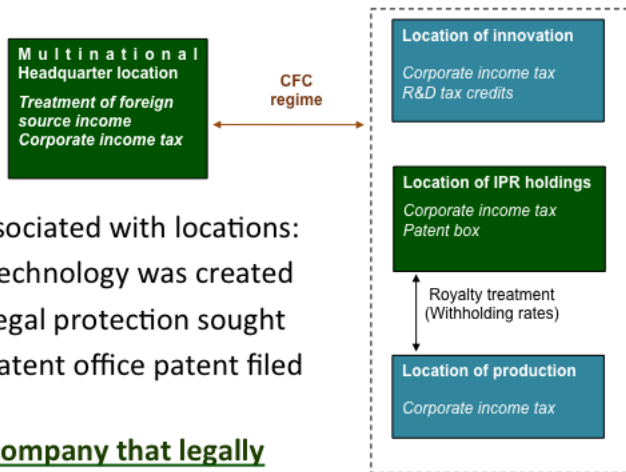
The income from intangible assets is mobile

- Intangible assets are easier to move around
- In particular intellectual property (patents, copyrights, trademarks) ... exclusive rights to exploit an idea
- Intellectual property traditionally held close to home
 - but firms are increasingly holding income from intellectual property separate from other activity
- A tax lawyer quoted in the New York Times noted,
 - *“...most of the assets that are going to be reallocated as part of a global repositioning are intellectual property, ... that is where most of the profit is.”*

Taxing income from Intellectual Property

- What impact do taxes on income from Intellectual Property have? What has been the impact of recent reforms in European countries?
- General reforms have shifted the tax burden away from mobile income
- Counter to that, Controlled Foreign Company (CFC) rules
 - CFC rules are anti-avoidance rules
 - in UK these tax income from intellectual property held offshore
- Recent introduction of Patent Boxes
 - tax income from patents at substantially lower rate
 - introduced in Benelux countries, UK, now others?
 - in UK estimated to cost over £1bn to exchequer

- 1 Model firms' choices over where to hold income from patents
 - estimate responsiveness to tax
 - allow for unobserved heterogeneity to obtain flexible substitution patterns
 - show that likely to lead to substantial revenue loss
- 2 Model strategic government tax setting
 - governments compete for firms in a Bertrand game
 - maximise revenue (net of benefits)
 - what are revenue maximising tax rates?
 - why have some countries introduced Patent Boxes?
 - how might other governments respond?



Patents associated with locations:

- where technology was created
- where legal protection sought
- which patent office patent filed at
- **where company that legally holds the patent is based**

Model of firm behaviour

- Firm has a successful discovery, decides location of subsidiary that will own the patent (hence where subsequent income will be taxed)
- Discrete choice model; firms choose location where value is highest
- Value to firm of holding patent in a location depends on:
 - revenue from patent
 - costs of holding patent in that subsidiary (taxes and fixed costs)
 - any benefits that arise from holding patent in that location

- Expected value to firm of a patent

$$\pi_{ipjt} = (1 - \tau_{ijt}) \varphi_p + \kappa_{ip} + \gamma_{rsj} + \epsilon_{ipjt}$$

- i firms; p patents; j countries; t time
- r technology/industry; s firm size
- φ_p expected pre-tax net present value of the patent
- τ_{ijt} : tax rate on patent income, including CFC regimes
- φ_p known to the firm but unobserved by econometrician; we assume $\varphi_p = \mu_{rs} + \sigma_{rs}\eta_p$ and $\eta_p \sim N(0, 1)$
- κ_{ip} firm-patent specific costs/benefits
- γ_{rsj} technology-size-location costs/benefits, mean that firms don't always chose the lowest tax location

Model of firm behaviour

- Firms choose location with highest π_{ipjt}
- Probability firm i locates patent p at time t in country j is:

$$L_{iptj} = \int_{\eta} l_{iptj}(\eta) dF(\eta)$$

$$l_{iptj} = \frac{\exp(-(\mu_{rs} + \sigma_{rs}\eta_p)\tau_{ijt} - \gamma_{rsj})}{\sum_k \exp(-(\mu_{rs} + \sigma_{rs}\eta_p)\tau_{ikt} - \gamma_{rsk})}$$

- Share of Ω_t patents arriving at time t that locate in country j is:

$$S_{ij}(\tau_t) = \frac{1}{P_t} \sum_{p \in \Omega_t} \int_{\eta} l_{iptj}(\tau_t; \eta) dF(\eta)$$

- Use estimates of this model to obtain the own and cross tax elasticities of patent income

$$\frac{\partial S_{jt}(\tau)}{\partial \tau_{jt}} \frac{\tau_{jt}}{S_{jt}(\tau)}$$

Model of government behaviour

- Governments compete for firms in a Bertrand game
- Set tax rate that applies to income from intellectual property, τ_{jt}
- Government sets the tax rate at time t assuming that it will hold into the indefinite future
- Tax is levied on a source basis
 - other aspects of the tax system that affect the way that corporate income is taxed, such as Controlled Foreign Companies (CFC) regimes, are fixed (we account for them by do not allow governments to optimise over them)
- Total amount of patent income is held fixed (or varies exogenously)

Model of government behaviour

- Governments seek to maximise expected net present value of the future stream of revenue,

$$\max_{\tau_{jt}} R_{jt} = (\tau_{jt} + \alpha_{jt}) S_{jt}(\tau_t) M_t$$

- M_t : total expected net present value of all future patent income
- $S_{jt}(\tau_t)$: share of patents arriving at time t that locate in country j
- α_{jt} : potential non-pecuniary benefits
 - (positive) external benefits such as knowledge spillovers
 - (negative) opportunities for tax avoidance
 - we assume are proportional to the tax base
- *note: we treat γ_{rsj} , benefits to firm of choosing location, as exogenously given*

- Government's first-order condition

$$(\tau_{jt} + \alpha_{jt}) \frac{\partial S_{jt}(\tau_t)}{\partial \tau_{jt}} + S_{jt} = 0$$

Counterfactual analysis

- What is optimal tax rate if governments pure revenue maximisers?
 - our result shows that most countries should reduce tax rates
 - but that Patent Boxes rates are below revenue maximising level
 - so why introduce Patent Boxes?
- If we assume governments maximise revenue net of benefits, what changes could rationalise introduction of Patent Boxes?
 - increase in benefits (α_{jt}), (e.g. externalities from patenting activity/income increasing)
 - increase in size of tax base (e.g. reducing tax increases patenting activity and/or income in Europe)
 - increase in elasticity (e.g. income from patents becoming more mobile)

Data: firms and patents

- Parent firms in thirteen European countries
- Location of all subsidiaries in fifteen countries (inc. US)
- Patent applications made to the European Patent Office (EPO) 1985-2005
 - address of applicant, the subsidiary that will own the intellectual property and the income that arises from its exploitation
 - closest proxy to where income will be taxed
 - distinct from location of parent firm, location of research lab (inventors), location in which legal protection sought

Patent example

(54) Title: USE OF AN ANGIOTENSIN II TYPE 1 RECEPTOR ANTAGONIST IN THE MANUFACTURE OF A MEDICAMENT FOR THE TREATMENT OF CARDIOVASCULAR COMPLICATIONS

(51) International Patent Classification: A61K 31/41, A61P 9/10

(21) International Application Number: PCT/SE00/01444

(22) International Filing Date: 5 July 2000 (05.07.2000)

(25) Filing Language: English

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(81) Designated States (national): AE, AG, AI, AM, AT, AU, AZ, BA, BB, BC, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PL, SE), OAPI patent (BF, BJ, CI, CG, CJ, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Swedish company Astra Zeneca AB holds application
Subsidiary of UK MNE Astra Zeneca
Invented in multiple countries (income split from activity)

- 233,471 patent applications
 - all EPO patent applications made by a corporate entity that we were able to match to a European parent firm (excluding small firms)
- made by 4,740 European and US subsidiaries
- owned by 639 European parent firms

- Statutory corporate rate in source country, 1985-2005
 - varies over time, differentially across countries
- Controlled Foreign Companies (CFC) regime in home country
 - gives variation by home country of parent firm

Tax rates

	Statutory tax rate 2005	Patent box rate
Belgium	34.0%	6.8%
Denmark	28.0%	
Finland	26.0%	
France	33.8%	
Germany	38.3%	
Ireland	12.5%	
Italy	37.3%	
Luxembourg	30.4%	5.9%
Netherlands	31.5%	10%
Norway	28.0%	
Spain	35.0%	
Sweden	28.0%	
Switzerland	21.3%	
UK	30.0%	10%

Estimates of firm behaviour

- Location choice model with heterogeneity
- Observed heterogeneity
 - all coefficients vary across 6 industry-size categories
 - Chemicals, Electrical, Engineering
 - Large firms (above 80 pctile of patenting)
 - Medium firms (20 to 80 pctile of patenting)
- Unobserved heterogeneity
 - random coefficient on tax rate, allowing unobserved heterogeneity in response to tax across individual patents
 - allows correlation between options, countries seen as differentially substitutable for each other; yields more variation in cross-tax elasticities

Own and cross tax elasticities

	Belgium	Denmark	Finland	France	Germany	Ireland	Italy
Belgium	-1.006	0.031	0.051	0.171	0.026	0.001	0.042
Denmark	0.064	-1.375	0.056	0.261	0.076	0.001	0.089
Finland	0.055	0.030	-1.568	0.471	0.112	0.001	0.062
France	0.030	0.023	0.077	-0.917	0.035	0.000	0.031
Germany	0.011	0.016	0.046	0.087	-0.642	0.000	0.016
Ireland	0.082	0.081	0.083	0.311	0.094	-0.768	0.129
Italy	0.028	0.029	0.038	0.117	0.025	0.001	-0.842
Luxembourg	0.058	0.056	0.045	0.194	0.074	0.001	0.124
Netherlands	0.038	0.025	0.103	0.301	0.056	0.000	0.030
Norway	0.061	0.055	0.056	0.249	0.085	0.001	0.115
Spain	0.043	0.041	0.040	0.148	0.052	0.001	0.097
Sweden	0.052	0.035	0.119	0.365	0.090	0.001	0.063
Switzerland	0.069	0.061	0.085	0.336	0.094	0.002	0.087
UK	0.052	0.046	0.069	0.258	0.067	0.001	0.073
US	-0.007	0.012	0.031	-0.001	-0.075	0.000	-0.013

Own and cross tax elasticities

	Luxembourg	Netherlands	Norway	Spain	Sweden	Switzerland	UK	US
Belgium	0.006	0.168	0.006	0.004	0.080	0.111	0.143	-0.012
Denmark	0.011	0.228	0.011	0.007	0.109	0.193	0.257	0.038
Finland	0.005	0.486	0.006	0.004	0.193	0.147	0.202	0.054
France	0.003	0.232	0.004	0.002	0.097	0.095	0.124	0.000
Germany	0.003	0.109	0.004	0.002	0.060	0.069	0.080	-0.053
Ireland	0.017	0.252	0.016	0.014	0.136	0.461	0.318	0.053
Italy	0.008	0.089	0.008	0.005	0.064	0.091	0.132	-0.014
Luxembourg	-1.299	0.129	0.013	0.010	0.089	0.160	0.242	0.028
Netherlands	0.003	-1.067	0.004	0.002	0.124	0.116	0.148	0.018
Norway	0.013	0.183	-1.340	0.008	0.105	0.168	0.242	0.039
Spain	0.012	0.090	0.010	-1.081	0.068	0.099	0.171	0.018
Sweden	0.006	0.359	0.007	0.004	-1.405	0.146	0.196	0.043
Switzerland	0.010	0.316	0.011	0.005	0.140	-0.857	0.276	0.052
UK	0.008	0.239	0.009	0.005	0.109	0.160	-1.181	0.026
US	0.002	0.048	0.002	0.001	0.040	0.058	0.044	-0.266

Firms responsiveness to tax

	Statutory tax rate 2005	Own tax elasticity (linear in tax)	Own tax elasticity (inc tax squared)
Belgium	34.0%	-1.006	-1.214
Denmark	28.0%	-1.375	-1.641
Finland	26.0%	-1.568	-1.428
France	33.8%	-0.917	-0.930
Germany	38.3%	-0.642	-0.709
Ireland	12.5%	-0.768	-0.978
Italy	37.3%	-0.842	-0.972
Luxembourg	30.4%	-1.299	-1.567
Netherlands	31.5%	-1.067	-1.063
Norway	28.0%	-1.340	-1.521
Spain	35.0%	-1.081	-1.243
Sweden	28.0%	-1.405	-1.365
Switzerland	21.3%	-0.857	-1.038
UK	30.0%	-1.181	-1.342

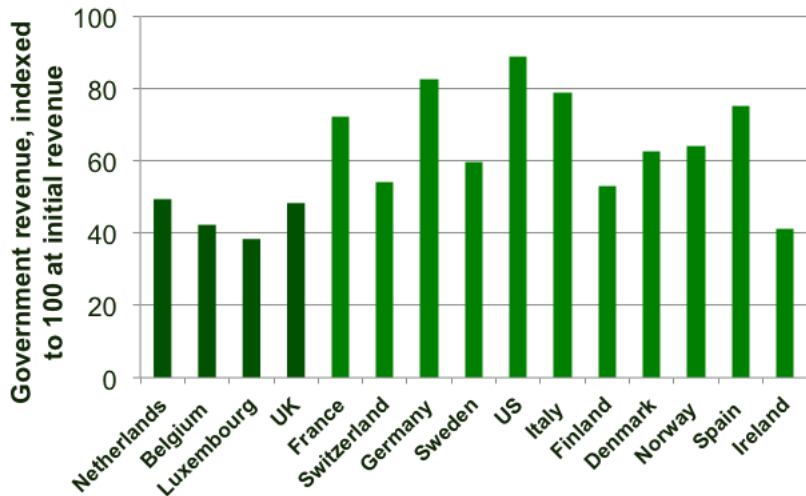
What impact will Patent Boxes have?

- Predict shares at new Patent Box rates

	Statutory tax rate 2005	Patent box rate
Belgium	34.0%	6.8%
Luxembourg	30.4%	5.9%
Netherlands	31.5%	10%
UK	30.0%	10%

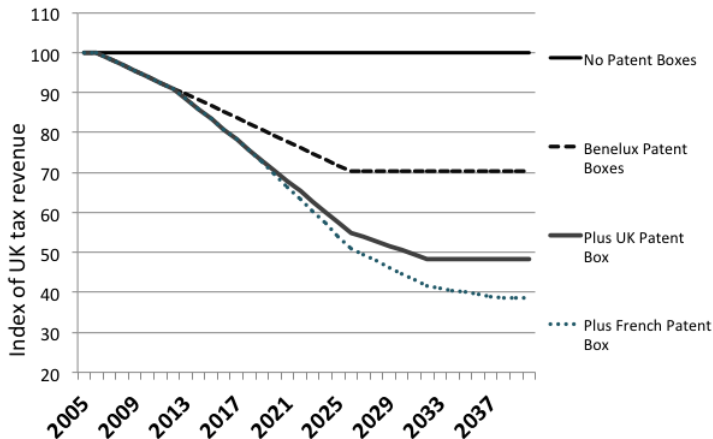
- Share increase in countries introducing patent box; but taxed at lower tax rate, so unclear what net impact will be
- Shares fall in all others countries, amount they fall depends on how close substitutes they are

Revenue impact of patent boxes



Revenue impact of patent boxes, over time for the UK

- Depends on precise rules (rules announced in last Budget)



- What is optimal tax rate if governments pure revenue maximisers?
 - assume there are no costs or benefits, so $\alpha_{jt} = 0$
 - rearranging the first-order condition gives us revenue maximizing tax rate is when own tax elasticity = -1

$$\frac{\tau_j^*}{S_{jt}(\tau_{jt}^*, \tau_{-jt})} \frac{\partial S_{jt}(\tau_{jt}^*, \tau_{-jt})}{\partial \tau_{-jt}^*} = \varepsilon_{jt} = -1$$

Counterfactual analysis

	Statutory tax rates 2005	Optimal tax rate with $\alpha_j = 0$	Patent box rate
Belgium	34.0%	22%	6.8%
Denmark	28.0%	22%	
Finland	26.0%	22%	
France	33.8%	26%	
Germany	38.3%	41%	
Ireland	12.5%	21%	
Italy	37.3%	23%	
Luxembourg	30.4%	21%	5.9%
Netherlands	31.5%	24%	10%
Norway	28.0%	21%	
Spain	35.0%	21%	
Sweden	28.0%	23%	
Switzerland	21.3%	24%	
UK	30.0%	23%	10%

Counterfactual analysis

- Most countries should reduce tax rates, except Germany and Ireland
- But Patent Boxes rates are below revenue maximising level, other rationalisations?
- Assume governments maximise revenue net of benefits; what changes could ensure that R was at least as large after the introduction of Patent Boxes as it was before?

$$\left(\tau_j^{PB} + \alpha_j^{PB}\right) s_j^{PB} M^{PB} = \left(\tau_j + \alpha_j\right) s_j M$$

Counterfactual analysis

- Other rationalisations?
- increase in benefits (α_{jt}), (e.g. externalities from patenting activity/income is increasing)
- increase in size of tax base (e.g. reducing tax increases patenting income)
- increase in elasticity (e.g. income from patents becoming more mobile)

Counterfactual analysis

- Increase in costs/benefits (α_{jt})
 - recover α_{jt}

$$\alpha_{jt} = - \left(\frac{1}{\frac{\partial S_{jt}(\tau)}{\partial \tau_{jt}} \frac{\tau_{jt}}{S_{jt}(\tau_t)}} + 1 \right) \tau_{jt}$$

- what increase in α_{jt} would ensure that R was at least as large after the introduction of Patent Boxes as it was before?

$$\left(\tau_j^{PB} + \alpha_j^{PB} \right) s_j^{PB} M^{PB} = \left(\tau_j + \alpha_j \right) s_j M$$

- implies that

$$\alpha_j^{PB} = \frac{s_j}{s_j^{PB}} \left(\tau_j + \alpha_j \right) - \tau_j^{PB}.$$

Counterfactual analysis

	Statutory tax rate 2005	Own tax elasticity	Implied α_j	α_j that rationalises Patent Box
Belgium	34.0%	-1.006	-0.21%	9.14%
Denmark	28.0%	-1.375	-7.64%	
Finland	26.0%	-1.568	-9.42%	
France	33.8%	-0.917	3.05%	
Germany	38.3%	-0.642	21.38%	
Ireland	12.5%	-0.768	3.79%	
Italy	37.3%	-0.842	6.96%	
Luxembourg	30.4%	-1.299	-6.99%	5.95%
Netherlands	31.5%	-1.067	-1.98%	8.97%
Norway	28.0%	-1.340	-7.11%	
Spain	35.0%	-1.081	-2.64%	
Sweden	28.0%	-1.405	-8.08%	
Switzerland	21.3%	-0.857	3.56%	
UK	30.0%	-1.181	-4.59%	7.52%

- Increase in size of tax base
 - Reducing tax could lead to increase in tax base
 - firms relocate income from intangible assets from outside Europe into Europe
 - firms substitute from tangible to intangible assets
 - overall expansion in productive activity
 - what increase in M would ensure that R was at least as large after the introduction of Patent Boxes as it was before

$$\frac{M^{PB}}{M} = \frac{s_j (\tau_j + \alpha_j)}{s_j^{PB} (\tau_j^{PB} + \alpha_j)}$$

Counterfactual analysis

	Statutory tax rates 2005	Own tax elasticity	M^{PB} / M that rationalises Patent Box
Belgium	34.0%	-1.006	2.42
Denmark	28.0%	-1.375	
Finland	26.0%	-1.568	
France	33.8%	-0.917	
Germany	38.3%	-0.642	
Ireland	12.5%	-0.768	
Italy	37.3%	-0.842	
Luxembourg	30.4%	-1.299	-
Netherlands	31.5%	-1.067	2.36
Norway	28.0%	-1.340	
Spain	35.0%	-1.081	
Sweden	28.0%	-1.405	
Switzerland	21.3%	-0.857	
UK	30.0%	-1.181	3.24

- Increase in mobility of tax base (elasticity), calculate the increase in the share that would need to be achieved

$$s_j^{PB} = \frac{(\tau_j + \alpha_j) s_j M}{(\tau_j^{PB} + \alpha_j^{PB}) M}$$

- Belgium, from 7.9% to 19.1%
- Netherlands, from 28.6% to 67.5%
- UK, from 16.8% to 54.4%

- Specify model of firm and government behaviour; estimate and allow for unobserved heterogeneity to allow flexible substitution patterns
- Considering equilibrium
 - Most countries should reduce tax rates, except Germany and Ireland
 - Patent Boxes rates are below revenue maximising level
 - Patent boxes will lead to substantial relocation of income and revenue cost
 - Why were they introduced?

- Increase in net benefits, scale of patenting activity or elasticity needed to rationalise Patent Boxes seem implausibly large
- Further work
 - improve estimates of elasticities
 - patenting highly skewed; are a few firms driving policy?
 - perhaps “no change” is incorrect counterfactual; downward pressure on taxes

- Patenting is highly skewed; a small number of firms own a large share of patents
- In the UK 5 firms account for 20% of patents filed from a UK company
- Governments may give more weight to the activities of these firms
- GlaxoSmithKline and Rolls Royce were represented in a "Working Group of representatives from businesses established to complement wider consultation on the Patent Box and to discuss options and proposals in more detail."
- Model of bargaining over tax rate

- A way to tax relatively mobile activities at a lower rate
 - avoid deterring mobile activities while allowing a higher rate on less mobile activities
 - an efficient way to raise revenues or a road to tax competition?
 - preferential rates can be shown to either isolate tax competition in one part of the tax system (higher overall revenue) or lead to no taxation on mobile income (lower overall revenue)