UCD CENTRE FOR ECONOMIC RESEARCH

WORKING PAPER SERIES

2020

Competition in Taxes and IPR

Ronald B Davies, University College Dublin
Yutao Han, University of International Business and Economics
Kate Hynes, Dublin City University
Yong Wang, City University of Hong Kong

WP20/19

June 2020

UCD SCHOOL OF ECONOMICS
UNIVERSITY COLLEGE DUBLIN
BELFIELD DUBLIN 4

Competition in Taxes and IPR

Ronald B. Davies[a], Yutao Han[b], Kate Hynes[c], and Yong Wang[d] *

[a]University College Dublin; Email: ronbdavies@gmail.com.
[b]University of International Business and Economics; Email: yutao.han@uibe.edu.cn.
[c]Dublin City University; Email: kate.hynes@dcu.ie.
[d]City University of Hong Kong; Email: efywang@cityu.edu.hk.

June 16, 2020

Abstract

We examine competition for foreign direct investment when governments compete in tax incentives along with intellectual property rights (IRPs) protection. Higher IPRs result in a lower probability of the multinational enterprise (MNE) being imitated and thus higher expected profits and tax revenues, all else equal. We show that, from the perspective of competing hosts, equilibrium IPRs are too high while taxes are too low. Coordination between jurisdictions can therefore lower the multinational's expected payoff, providing a rationale for why during recent trade negotiations FDI home countries complain about low IPRs in some locations while not pushing for them to be centrally determined.

JEL Classification: F23, H25, 034

Keywords: Tax competition, FDI, IPRs, Imitation.

*We thank conference participants at the European Trade Study Group, Australasian Trade Workshop, and the BJUT workshop on "Global Production, Taxes, and Trade" as well as seminar participants at Florida Southern College, University College Dublin, University of Melbourne, Deakin University and RMIT for helpful comments. Any errors or omissions are completely our own.

1 Introduction

The decision of where to locate foreign direct investment (FDI) depends on a number of factors including production costs and taxation. Increasing attention is also being given to the role of intellectual property rights (IPRs) since multinationals rely heavily on their intangible assets.[1] IPRs also factor into the political conflict over globalization. For example, the U.S. has recently accused China of ignoring the appropriation of intellectual property of American multinational enterprises (MNEs) who have invested in China, claiming that imitation by Chinese firms costs the US over $600 billion annually (USTR, 2019). In particular, there is widespread recognition that the extent of imitation varies widely across provinces (Massey, 2006). Using data on the court delays in contract enforcement as a proxy for IPRs, Figure 1 illustrates this variation across provinces with darker regions where IPR enforcement is more lax.[2] In addition, Figure 2 shows that taxes differ considerably across jurisdictions as well.[3] As Liu and Martinez-Vazquez (2014) indicates, there is evidence of inter-regional tax competition for footloose capital among Chinese provinces which can help to explain such variation.

Concerns over weak IPRs in some regions of China have motivated US demands for Beijing to mandate higher IPR protection across all provinces. To date, however, China has not done so. Furthermore, despite such concerns an impetus for retaliatory tariffs by the US against Chinese goods in 2018, the issue has been sidelined during discussions seeking to resolve the trade war. This raises the question of why a home country would not seek for tax and IPR policies so crucial to its MNEs to be set centrally. In this paper, we provide one explanation based on competition in taxes and IPRs for FDI. Because IPRs reduce the possibility of imitation, this works to the detriment of local consumers (an increasingly important market for FDI in China). Local jurisdictions, however, only recognize how this effects their own consumers. As such, decentralized IPRs are higher in equilibrium than what they would be if they were instead set by a federal government. Although the cost of IPR enforcement can be offset somewhat by charging higher taxes, the net result is a transfer of surplus from the host to the MNE. Such a result can even arise when the federal government sets taxes or IPRs but leaves the other policy instrument open to competition. Thus, while fiery rhetoric about theft of intellectual property may make headlines (and catch votes), in many cases it is not in the MNE's best interest to actually pursue centralized setting of such policies.

Specifically, we construct a model with two jurisdictions competing for a MNE using IPR protection enforcement and profit taxes. The two jurisdictions can differ in terms of wages and the ease of implementing IPR enforcement (the cost of IPRs). The MNE can invest in one of the two jurisdictions or remain at home and export. If it undertakes FDI, it faces potential local imitation even as it gains access to reduced production costs. Governments determine their policy mix to maximize their own welfare which includes tax revenue earned from the MNE, the cost of IPR enforcement, and the surplus generated by consuming the MNE's good. This latter depends on prices and hence on whether or not there is imitation, something that

[1] See Davies and Markusen (forthcoming) for a recent discussion.

[2] These can be found at `https://data.worldbank.org/indicator/IC.LGL.DURS` and are the same data used by Chen, et al. (2018).

[3] This figure uses data from the Annual Survey of Industrial Firms (ASIF) conducted by the National Bureau of Statistics of China. These data contain all industrial firms that are either state-owned or are non-state firms with annual sales of five million Yuan (about $650,000) or higher.

also affects taxable profits and thus tax revenues. This linkage highlights the value in considering taxes and IPRs simultaneously. In particular, because a local government does not consider the benefit to other consumers if imitation pushes prices down, it overweights the relative value of tax revenues and sets higher IPR levels than would a federal government that considers all consumers. Although this can be corrected by joint policy determination, doing so lowers IPRs and expected pre-tax profits. When competition occurs only in taxes, this may lead to higher MNE profits, however this is not always the case even when jurisdictions are identical. Therefore while the MNE and its home government may prefer higher IPRs all else equal, demanding centralized setting of them may not achieve the desired result. Note that this preference for competition is not shared by the federal government representing the jurisdictions, which instead prefers coordination and weaker IPRs. This latter is thus reminiscent of developing countries' opposition to the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement which sets out to achieve minimum standards for protecting and enforcing nearly all forms of IPRs.

To the best of our knowledge, our model represents the first attempt at combining competition in IPRs with competition in taxes. That said, we contribute to sizable literatures examining these separately. The theoretical studies on the role of IPR in FDI decisions are largely embedded in North-South product cycle models pioneered by Grossman and Helpman (1991a). In these models, FDI serves as a channel through which Northern innovation is diffused to the South. Although the focus of this strand of literature is to study how IPR protection affects innovation, growth and welfare, FDI is shown to play a central role. For instance, in the early work of Grossman and Helpman (1991b), where FDI is absent and imitation serves as the channel of technology diffusion, the authors found that strengthening IPR in the South in fact lowers the innovation rate in the North. This result, however, is reversed in a similar variety expansion model studied by Lai (1998) where FDI, rather than imitation, serves as the diffusion channel of Northern technology. There are two consensus emerging from the studies in this strand of literature. One finds a positive relationship between IPR protection and FDI (Lai, 1998; Helpman, 1993; Branstetter and Saggi, 2011; Tanaka and Iwaisako, 2014)[4] and the other finds a negative relationship (Glass and Saggi, 2002; Glass and Wu, 2007).[5] Chen and Puttitanun (2005) investigate the trade-off between imitating foreign technologies and encouraging domestic innovation in a developing country's choice of IPRs.

Similar to the theoretical prediction, the empirical results on the relationship between the strength of IPR protection and FDI decisions are also inconclusive. The early study by Lee and Mansfield (1996) found support in a positive correlation between IPR strength and FDI volume based on the survey data of 100 US multinational firms. This result is further corroborated in Smith (2001). However, Braga and Fink (1998) found no significant relationship between

[4]Lai (1998) found that FDI and IPR protection are positively related. In another paper focusing on welfare analysis of IPR, Helpman (1993) showed that a tighter IPR policy in the South, which may or may not increase innovation rate in the North, does not necessarily raise the Southern welfare. In this regard, the introduction of FDI, which responds positively to IPR tightening, has a positive impact on Southern welfare. The study by Branstetter and Saggi (2011) with endogenous imitation and FDI, a strengthening of IPR is associated with rising FDI relative to imitation activities and hence results in rising relative wage in the South. Tanaka and Iwaisako (2014) find a positive relationship between IPR and FDI when a research and development subsidy is introduced into a quality ladder model.

[5]These studies find a negative relationship between IPR protection and FDI in a quality ladder model of innovation.

these two variables after controlling for industry characteristics. McCalman (2004) argued that IPR regime may also affect the entry mode of MNEs in terms of FDI versus licensing agreements, and found evidence that the effect of IPR reforms on FDI may be non-monotonic. More recent studies rely on disaggregated data at industry or firm level data (see, for example, Nunnenkamp and Spatz, 2004; Javorcik, 2004; and Branstetter et al., 2006 and 2010). By and large, these studies find a limited effect of IPRs on the volume of FDI but significant impacts on its quality, the composition of sectors, and the types of projects.

Our paper is also related to studies investigating how jurisdictions compete for MNEs with fiscal policies. Examples of fiscal competition among countries for a single firm are numerous (see, e.g., Black and Hoyt, 1989; Haufler and Wooton, 1999; Haufler and Wooton, 2006; Davies, 2005; Davies and Ellis, 2007; Fumaglli, 2003; Bjorvatn and Eckel, 2006). Ferrett and Wooton (2010) consider fiscal competition for two firms in a duopoly framework. Behrens and Picard (2008) and Ottaviano and Ypersele (2005) investigate tax/subsidy competition to bid for horizontally differentiated multinationals. More recently, Haufler et al. (2014) studies the effect of tax policies on entrepreneurs' choice of riskiness of an innovation project, and on their mode of commercializing the innovation.[6] Other studies, although smaller in volume have highlighted the importance of focusing on other single or multiple government policies that can be used to attract MNEs. For instance the interaction of taxes and investments in public infrastructure (Han et al. (2017) and Dewit et al., 2018), taxes and transport investments (Hynes et al., 2019), labour standards (Davies and Vadlamannati, 2017) and environmental standards (Davies and Naughton, 2014). As far as we are aware this paper is the first attempt to examine both IRPs and taxes in a game theoretic framework.

The paper proceeds as follows. In Section 2, we lay out the basics of the model. Section 3 derives the equilibrium when jurisdictions compete in taxes and IPRs. In Section 4, we turn our attention to different degrees of joint policy formation. Section 5 concludes.

2 The Model

Consider a setting with a country comprised of two jurisdictions, $i = \{1, 2\}$, who are competing for an investment project by a MNE from another country.[7] Each jurisdiction has two policies at its disposal: a profit tax t_i and the probability of the MNE facing competition from a local imitator, $\phi_i(g_i)$, which is a decreasing and convex function of IPR expenditures g_i.[8] We assume that imitation in i is not possible if the MNE is not present in that jurisdiction. From the MNE's perspective, lower taxes and higher IPRs are both desirable. From a government's point of view, while lower taxes are less beneficial all else equal, there is a tradeoff from

[6] The literature on tax competition is vast. The theoretical studies on tax competition are motivated by the view that competition for international capital leads to inefficiently low tax rates and public expenditure levels. This view was formally modelled by Zodrow and Mieszkowski (1986) and Wilson (1986). Following the theoretical work, empirical studies provide strong evidence for tax competition between countries (e.g., Devereux, Lockwood, and Redoano 2008). Recent surveys on tax competition include Zodrow (2010) and Baskaran and Lopes da Fonseca (2013).

[7] As discussed in the introduction, our analysis on IPR competition is most naturally applicable to developing jurisdiction hosts. This will also inform some of our choices regarding wage differentials.

[8] In addition, as described below, to avoid corner solutions we will assume that $\phi_i'(0) = -\infty$ and that $\phi_i(\infty) > 0$ so that it is impossible to prevent imitation. We also assume that $\phi(0) = 1$, i.e. no IPR expenditures result in certain imitation.

higher IPRs. On the one hand, stronger IPRs are attractive because they increase the MNE's expected profits, thus increasing tax revenues. Weaker IPRs, however, both cost less and, by increasing the chance of competition, result in lower expected prices benefitting consumers.[9] Note that this lower price would also benefit consumers in the non-host jurisdiction. Exploring the interplay of these differing motivations, both unilaterally and jointly between the two potential hosts, is our primary goal.

Each jurisdiction has a single representative consumer endowed with an exogenous amount of labour L_i which is the sole factor of production. This consumer derives utility from consuming two goods, a numéraire (n_i) and the good produced in the MNE's sector x_i. Consumers in both jurisdictions have identical, quasi-linear preferences described by:

$$u_i(x_i, n_i) = \upsilon(x_i) + n_i \tag{1}$$

where $\upsilon'(x_i) > 0$ and $\upsilon''(x_i) < 0$.

The numéraire is assumed to be produced in both jurisdictions, i.e. when the MNE locates in i, labour demand by the MNE is less than L_i in equilibrium. This good is freely-traded and perfectly competitive with a price that is normalized to one. The constant unit labour requirement in jurisdiction i is w_i^{-1} so that the wage rate in jurisdiction i is w_i.[10] Without loss of generality, let $w_1 \leq w_2$.

The MNE's good is subject to free resale and incurs no domestic transport costs, making its price p_i the same across jurisdictions.[11] We assume that in the event of imitation that firms engage in Bertrand competition. The good is produced under constant returns to scale with a unit labour requirement equal to 1. The price therefore depends on where the good is produced (as wage costs differ) as well as whether or not there is an imitator. In any case, assuming an interior solution, demand for the MNE's good in i is $x_i(p)$ which is given by:

$$\upsilon'(x_i(p)) = p \tag{2}$$

Note that at a common price, $x_1(p) = x_2(p)$. Denote aggregate demand by $X(p)$, which is the sum of these plus, if desired, demand from sales in additional unmodelled countries (including home).

The MNE can remain at home (i.e. be an exporter rather than an MNE) or locate in one of the two hosts. If it remains at home, it faces a total, per-unit production cost of $w_h > \max\{w_1, w_2\}$.[12] Given the home profit tax $t_h < 1$, the maximum level of profits when producing in home:

$$(1 - t_h)\pi_h - F = (1 - t_h)(p_h - w_h)X(p_h) - F \tag{3}$$

where F is the fixed cost of innovation and the equilibrium price is determined by $p_h - w_h = -\frac{X(p_h)}{X'(p_h)} > 0$. Note that we assume that innovation happens at home and, to avoid dealing with the taxation of negative home profits if the MNE undertakes FDI, that they are non-tax

[9] By virtue of Bertrand competition, with imitation there are no taxable profits and thus this is not a benefit of the emergence of a local competitor.

[10] Thus, we can allow for productivity differences across hosts.

[11] There may, however, be international transport costs such as when importing from home.

[12] Although this would suggest that productivity in the numéraire is lower at home this can also arise from international trade costs, labour market rigidities in home, or another product which is neither consumed nor produced in the hosts.

deductable.[13] Note that, unlike when producing in a host country, if there is no chance of imitation at home. We assume that innovation costs are small enough so that, if the firm locates at home, it always innovates and produces.

Alternatively, suppose that the firm locates in host i. If it does so, it may or may not be imitated. If the MNE is not imitated, then its optimal price is so that $p_i - w_i = -\frac{X(p_i)}{X'(p_i)} > 0$ resulting in profits:

$$(1 - t_i)\,\pi_i - F = (1 - t_i)\,(p_i - w_i)\,X\,(p_i) - F. \tag{4}$$

The tax and IPR expenditure policies determine where the MNE will locate however the optimal pricing for the good is independent from these policies. Given the ranking of wages, this implies that with equal taxes and IPR expenditures that $\pi_1 \geq \pi_2$ with strict inequality when wages differ. If the MNE is imitated, it then engages in Bertrand competition with a local competitor with access to the same production technology. In this case, prices are driven down to marginal cost (w_i) and profits are $-F$. Thus, expected profits from locating in jurisdiction i are:

$$(1 - t_i)\,\pi_i^E\,(g_i) - F = (1 - t_i)\,(1 - \phi_i\,(g_i))\,(p_i - w_i)\,X\,(p_i) - F. \tag{5}$$

To close the model, by quasi-linear preferences, expenditures on the numéraire are income, y_i, less those on the MNE's good, $px_i\,(p)$.[14] Income is derived from wages plus net government income. This latter is expected tax revenues $t_i\pi_i^E\,(g_i)$ if i hosts and zero otherwise minus IPR expenditures. Defining consumer surplus from consumption of the MNE's good as $C_i\,(p) = \upsilon\,(x_i\,(p)) - px_i\,(p)$, we can write indirect utility as:

$$U_i\,(p, y_i) = C_i\,(p) + y_i \tag{6}$$

where the price and income depend on MNE location and imitation.

The timing of the game is as follows. First, both governments simultaneously choose their taxes and level of IPR expenditure. Second, the MNE chooses where to produce (home, jurisdiction 1, or jurisdiction 2). To avoid the need for messy but intuitive complications in exposition, we assume that when expected profits are the same, that the MNE chooses the highest gross-of-tax profits jurisdiction or, if these are equal, that it randomizes between them. Third, nature determines whether or not there is a local imitator. Finally, production occurs and payoffs accrue. We solve the game via backwards induction.

2.1 MNE Location Choice

Knowing the wages across locations and anticipating the probability of imitation, the MNE chooses the location that gives it the highest level of expected profits. A key aspect of this is its willingness to trade off higher IPRs for higher taxes. Holding expected profits constant, from Equation 5, this can be done by shifting taxes and IPR expenditures along an iso-profit policy tradeoff which keeps profits constant so that:

$$(1 - \phi_i(g_i))dt_i = -\phi_i'\,(g_i)\,(1 - t_i)dg_i. \tag{7}$$

[13] Specifically, we are assuming territorial taxation, consistent with the bulk of nations in practice. This lack of deductability could also be justified if this is non-deductable entrepreneurial effort.

[14] Recognize that so long as $y_i \geq px_i\,(p)$ in equilibrium, then Equation 2 is satisfied.

Thus, comparing jurisdictions 1 and 2, the MNE is trading off between wages, taxes, and the probability of imitation. When wages are equal, the comparison runs only along these two policy dimensions. Note that in such a case this is not simply a comparison of tax rates and levels of IPR expenditure as the model is flexible enough to allow for differences in the mapping between expenditures and the probability of imitation (that is, the $\phi_i(g)$ functions can differ). This might be the case if, for example, it is more difficult to enforce IPRs in rural regions than in urban ones.

3 Equilibrium Policies under Competition

In this section, we derive the equilibrium of the model when jurisdictions compete in taxes and IPRs.

Knowing that the MNE will choose the production location yielding the highest expected profit, jurisdiction i chooses t_i and g_i taking as given the choices of the other potential host (recall that the home country is assumed to be passive, i.e. t_h is exogenous). In order to win the MNE, it must match the expected profits in the next best alternative. Presuming that the MNE is to locate in i, the government chooses its two policy parameters to maximize its expected indirect utility:

$$U_i^E = (1 - \phi_i(g_i)) C_i(p_i) + \phi_i(g_i) C_i(w_i) + w_i L_i - g_i + t_i \pi_i^E(g_i) \tag{8}$$

subject to the constraint that $(1 - t_i)\pi_i^E(g_i) \geq max\{(1 - t_{-i})\pi_{-i}^E(g_{-i}), (1 - t_h)\pi_h\}$. Note that because expected indirect utility is strictly increasing in income, and thus the tax rate, the constraint will bind in equilibrium. Where λ is the Lagrange multiplier, this yields a first order condition for t_i of :

$$1 - \lambda = 0. \tag{9}$$

The interpretation of this result is that, given its optimal choice of g_i, the government will increase its tax until the MNE is indifferent between choosing to locate in i or in its next best alternative. An important aspect of this is that the shadow value of taxation, λ, is constant, i.e. the use of the profit tax is non-distortionary and only affects the location choice. Note that this implies that pre-tax profits above those earned in the next-best alternative accrue to the host jurisdiction. With this in hand, the first order condition for IPR expenditures reduces to:

$$\phi_i'(g_i^*)\{C_i(w_i) - C_i(p_i)\} - 1 = \phi_i'(g_i^*)(p_i - w_i) X(p_i). \tag{10}$$

where * denotes the equilibrium value. In this, the left hand side of the equation captures the marginal cost of IPR expenditures which has two components. The first term represents the loss to i's consumers from a lower chance of imitation and thus higher expected prices. The second is the marginal monetary cost of IPR enforcement which is constant and equal to 1. The right hand side represents the marginal benefit of IPRs which are the increase in expected tax revenues as the probability of imitation falls. Note that the optimal IPR expenditure, g_i^* is independent of both i's tax rate and the policies set by the other government. This is because the other jurisdictions policies only affect i via the outside profit level which must be

matched. Since i can do so via its own tax without generating additional distortions (recall that the shadow value of taxation is constant), it has no incentive to use its IPR policy, which affects expected consumer surplus, as the mechanism for responding to the other jurisdiction's policy. This tax rate is:

$$t_i\left(t_{-i}, g_{-i}, t_h\right) = 1 - \frac{max\{\left(1-t_{-i}\right)\pi_{-i}^E, \left(1-t_j\right)\pi_h\}}{\pi_i^E\left(g_i^*\right)}. \tag{11}$$

Note that this tax may be negative (i.e. a subsidy) when the outside option is more profitable than the pre-tax profits earned in i. Equations 10 and 11 then indicate the optimal mix of policies in which a government sets its optimal imitation probability $\phi_i^* = \phi_i\left(g_i^*\right)$ and uses its tax to keep the MNE indifferent between choosing i and the firm's next best alternative.[15] In this case, using Equation 11, the maximum expected utility from winning the MNE is:

$$\begin{array}{l} U_i^{E,win}\left(t_{-i}, g_{-i}, t_h\right) = \left(1-\phi_i^*\right)C_i\left(p_i\right) + \phi_i^* C_i\left(w_i\right) \\ +w_i L_i - g_i^* + \pi_i^E - max\{\left(1-t_{-i}\right)\pi_{-i}^E\left(g_{-i}\right), \left(1-t_h\right)\pi_h\}. \end{array} \tag{12}$$

The above assumed that the government wishes to attract the MNE. Alternatively, the government could decide to simply not compete and cede the MNE to its next best alternative. In this case, i's tax is irrelevant and there is only a cost to IPR expenditures. This would mean that, knowing it will not attract the MNE, it will set $g_i = 0$, so that expected indirect utility is:

$$U_i^{E,lose}\left(t_{-i}, g_{-i}, t_h\right) = \begin{cases} \left(1-\phi_{-i}^*\right)C_i\left(p_{-i}\right) + \phi_{-i}^* C_i\left(w_{-i}\right) + w_i L_i & \text{if } \left(1-t_{-i}\right)\pi_{-i}^E\left(g_{-i}\right) \geq \left(1-t_h\right)\pi_h \\ C_i\left(p_h\right) + w_i L_i & \text{if } \left(1-t_{-i}\right)\pi_{-i}^E\left(g_{-i}\right) < \left(1-t_h\right)\pi_h \end{cases} \tag{13}$$

Note that when it does not host the MNE, since $w_{-i} < w_h$, that i prefers the MNE to produce in $-i$ rather than at home regardless of whether or not there is imitation.

Whether or not jurisdiction i chooses to fight for the MNE depends on whether or not it expects to gain from doing so. To avoid cumbersome discussion, we assume that, in the case of indifference, the government chooses to fight for the MNE by using g_i^* and $t_i\left(t_{-i}, g_{-i}, t_h\right)$. Thus, combining the above results in the best response as described in our first proposition.

Proposition 1 *If* $U_i^{E,win}\left(t_{-i}, g_{-i}, t_h\right) \geq U_i^{E,lose}\left(t_{-i}, g_{-i}, t_h\right)$*, jurisdiction* i*'s best response tax and IPR expenditure are given by Equations 11 and 10 whereas if* $U_i^{E,win}\left(t_{-i}, g_{-i}, t_h\right) < U_i^{E,lose}\left(t_{-i}, g_{-i}, t_h\right)$ *its best response is to set* $g_i = 0$ *and its best response tax is indeterminant.*

From this, we can now derive the equilibrium. We do so in two steps. First, as Proposition 1 explains, under some circumstances a jurisdiction may not compete at all.

Proposition 2 *If*

$$\left(1-\phi_i^*\right)C_i\left(p_i\right) + \phi_i^* C_i\left(w_i\right) - g_i^* + \pi_i^E\left(g_i^*\right) < C_i\left(p_h\right) + \left(1-t_h\right)\pi_h$$

for some $i = 1, 2$*, there is no true competition between jurisdictions for the firm. If this holds for both jurisdictions, then the MNE locates home, both hosts have zero IPR expenditures,*

[15] Note that so long as $\phi'(0) = -\infty$ we are guaranteed that this results in a positive level of IPR expenditures.

and host taxes are indeterminant. If it holds only for i, then it spends nothing on IPR and its tax is indeterminant. The other jurisdiction, however, chooses g^*_{-i} and $t^*_{-i} = 1 - \frac{(1-t_h)\pi_h}{\pi^E_{-i}(g^*_{-i})}$ and hosts the MNE.

Proof.

Recall that, given that i is going to host the investment, g^*_i is a dominant strategy and its tax is set to leave the firm indifferent to the second most profitable location. Starting from a position where that next best alternative is home (and the MNE will earn $(1-t_h)\pi_h$), i would only seek to attract the MNE if:

$$(1-\phi^*_i)\,C_i(p_i) + \phi^*_i C_i(w_i) - g^*_i + \pi^E_i(g^*_i) - (1-t_h)\pi_h \geq C_i(p_h) \tag{14}$$

i.e. where the expected indirect utility is higher than allowing the firm to remain at home. If this is not the case, then i would cede the firm to the home country. When Equation 14 fails for both jurisdictions, neither will attempt to lure the firm, meaning that neither will invest in IPRs ($g_1 = g_2 = 0$). In addition, their taxes have no effect and are thus indeterminant.

Alternatively, suppose that it holds only for i. Again, if neither competes, the MNE locates at home. Although i is content with that, $-i$ is not and will lure the firm by setting g^*_{-i} and $t^*_{-i} = 1 - \frac{(1-t_h)\pi_h}{\pi^E_{-i}(g^*_{-i})}$. This increases i's expected indirect utility of ceding the firm because it lowers expected prices (both because of $w_{-i} < w_h$ and there is a chance of imitation).[16] It does not, however, change the expected value of winning the firm. This is because i's optimal IPR does not change nor does the outside profit target it must meet (recall that $-i$ is using its tax to exactly match π_h). Therefore, even as $-i$ attracts the MNE, i has no incentive to do so, making this an equilibrium. Therefore, when Equation 14 fails for at least one jurisdiction, there is no true competition between the jurisdictions for the MNE.

■

When Equation 14 holds for both firms, then true competition will arise, i.e. both will attempt to attract the MNE in equilibrium. The outcome of this competition is described in our next proposition.

Proposition 3 *If*

$$(1-\phi^*_i)\,C_i(p_i) + \phi^*_i C_i(w_i) - g^*_i + \pi^E_i(g^*_i) \geq C_i(p_h) + (1-t_h)\pi_h$$

for $i = \{1,2\}$, then in equilibrium IPR levels are given by g^*_1 and g^*_2. Equilibrium tax rates are such that the losing jurisdiction is indifferent between hosting and not competing for the investment whereas the hosting jurisdiction i gains so long as $\pi^E_i(g^*_i) - \pi^E_{-i}(g^*_{-i}) + g^*_i - g^*_{-i} > 0$.

Proof.

In this case, neither jurisdiction will cede the MNE to the home country. When competing, this means that each will use its most preferred IPR with taxes being used to compete for the MNE. This competition pushes taxes downwards until at least one of the two jurisdictions is

[16] Note that as policies are chosen simultaneously, the government in $-i$ takes the policies in i as given. Even were this not the case, as i's policies impact $-i$ only via the probability of imitation in i, as this is invariant to $-i$'s choices, $-i$ would not be able to profitably affect the outcome of the "competition" between i and the home country, resulting in the same policy choices.

indifferent between hosting the MNE and not. Without loss of generality, let the indifferent jurisdiction be $-i$. Given the equilibrium policies of i, $-i$ can compete resulting in expected indirect utility of:

$$\left(1-\phi_{-i}\left(g_{-i}^{*}\right)\right)C_{-i}\left(p_{-i}\right)+\phi_{-i}\left(g_{-i}^{*}\right)C_{-i}\left(w_{-i}\right)+\pi_{-i}^{E}\left(g_{-i}^{*}\right)-\left(1-t_{i}^{*}\right)\pi_{i}^{E}\left(g_{i}^{*}\right)-g_{-i}^{*} \quad (15)$$

Alternatively, if it knows it will not win, a best response is to set $g_{-i}=t_{-i}=0$ as in Proposition 2. This leaves it with expected indirect utility of:

$$\left(1-\phi_{i}\left(g_{i}^{*}\right)\right)C_{-i}\left(p_{i}\right)+\phi_{i}\left(g_{i}^{*}\right)C_{-i}\left(w_{i}\right). \quad (16)$$

To simply the presentation, define:

$$\Delta C=\left(1-\phi_{-i}\left(g_{-i}^{*}\right)\right)C_{-i}\left(p_{-i}\right)+\phi_{-i}\left(g_{-i}^{*}\right)C_{-i}\left(w_{-i}\right)-\left(1-\phi_{i}\left(g_{i}^{*}\right)\right)C_{-i}\left(p_{i}\right)-\phi_{i}\left(g_{i}^{*}\right)C_{-i}\left(w_{i}\right) \quad (17)$$

which is the difference in $-i$'s expected consumer surplus from the MNE's good when $-i$ hosts compared to when i does. Thus, $-i$'s indifference condition is:

$$\Delta C+\pi_{-i}^{E}\left(g_{-i}^{*}\right)-\left(1-t_{i}^{*}\right)\pi_{i}^{E}\left(g_{i}^{*}\right)-g_{-i}^{*}=0 \quad (18)$$

which then defines the optimal tax by i:

$$t_{i}^{*}=\frac{\pi_{i}^{E}\left(g_{i}^{*}\right)-\pi_{-i}^{E}\left(g_{-i}^{*}\right)+g_{-i}^{*}-\Delta C}{\pi_{i}^{E}\left(g_{i}^{*}\right)}. \quad (19)$$

Jurisdiction i, meanwhile, must make the MNE indifferent in order to win, i.e. that $\left(1-t_{i}^{*}\right)\pi_{i}^{E}\left(g_{i}^{*}\right)=\left(1-t_{-i}^{*}\right)\pi_{-i}^{E}\left(g_{-i}^{*}\right)$. Using Equation 18, this results in:

$$t_{-i}^{*}=\frac{g_{-i}^{*}-\Delta C}{\pi_{-i}^{E}\left(g_{-i}^{*}\right)}. \quad (20)$$

Finally, note that, for i to be satisfied, it cannot strictly prefer to not compete, i.e. that:

$$-\Delta C+\pi_{i}^{E}\left(g_{i}^{*}\right)-\left(1-t_{-i}^{*}\right)\pi_{-i}^{E}\left(g_{-i}^{*}\right)-g_{i}^{*}\geq 0 \quad (21)$$

which, when combined with Equation 18 is the same as:

$$\pi_{i}^{E}\left(g_{i}^{*}\right)-g_{i}^{*}\geq\pi_{-i}^{E}\left(g_{-i}^{*}\right)-g_{-i}^{*} \quad (22)$$

which must be true for at least one of the two jurisdictions. If this condition holds with strict inequality, then i strictly prefers to win the firm. Finally, by plugging in the equilibrium tax rate, we see that the firm's payoff is:

$$\pi_{-i}^{E}\left(g_{-i}^{*}\right)-g_{-i}^{*}+\Delta C. \quad (23)$$

■

Because competing in IPR expenditures is a second best method of attracting the MNE, taxes are the carrot used to lure the firm with each nation setting a tax just low enough to attract it. This is the same nature of competition found in many other tax competition

papers, e.g. Haufler and Wooton (1999), who model competition in taxes only, and Davies and Ellis (2007), who model competition in taxes and performance requirements. Although in this general setting it is not possible to determine which of the two jurisdictions will win with additional assumptions we can narrow this further.

Lemma 1 *Assume that both jurisdictions compete for the MNE, that* $w_1 = w_2 = w$*, and that* $\phi_2(g)$ *is an increasing, convex transformation of* $\phi_1(g)$*. Then jurisdiction* 1 *wins the MNE in equilibrium.*

Proof.

We follow a proof by contradiction, i.e. suppose that jurisdiction 2 wins the MNE in equilibrium. We know that this would require that 2 use g_2^* and that in equilibrium, 2 does not prefer to lose whereas 1 does not strictly prefer to win. Note that any expected profit in 2 can be reached in 1 by using $g_1 < g_2^*$ so that $\phi_1(g_1) = \phi_2(g_2^*) = \phi$ and the same tax rate t, leaving the MNE indifferent between locations. Since wages and thus prices are equal across jurisdictions, this means that 1's payoff from winning would exceed 2's payoff from winning under this IPR/tax combination:

$$\begin{aligned} &(1-\phi_2(g_2^*))C_1(p) + \phi_2(g_2^*)C_1(w) + t(1-\phi_2)(p-w)X(p) - g_1 \\ &> (1-\phi_2(g_2^*))C_2(p) + \phi_2(g_2^*)C_2(w) + t(1-\phi_2)(p-w)X(p) - g_2^* \end{aligned} \tag{24}$$

while the expected payoffs when conceding the MNE to the other jurisdiction is the same for both 1 and 2. Thus, for any tax/IPR combination where 2 is weakly prefers to win the MNE, 1 will strictly prefer to do so. Further, by moving to its best response g_1^* and resulting best response tax, 1 makes itself better off still. Thus, jurisdiction 2 will not host the MNE in equilibrium. ■

With equal wages, when one jurisdiction finds it easier to fight imitation, it can always match the expected profit of the other while enjoying a higher expected payoff. As such, it will always find it optimal to offer a combination of IPR protection and taxes that attract the MNE from the other host. Alternatively, suppose that jurisdictions have identical IPR probability functions but that jurisdiction 1 has strictly lower wages.

Lemma 2 *Assume that both jurisdictions wish to compete for the MNE,* $\phi_1(g) = \phi_2(g)$ *for all* g*, and that* $w_1 < w_2$*. Then jurisdiction* 1 *will host the MNE in equilibrium.*

Proof.

For any tax and IPR combination adopted by 2, if 1 uses those same policies then MNE after-tax profits are strictly higher in 1 by virtue of 1's lower wage costs. As such, 1 hosts. Since this implies that same IPR expenditure yet higher expected profits, higher expected tax revenues, and greater expected consumer surplus, 1 will earn higher expected indirect utility than 2 does. Therefore, at the policy combination where 2 is indifferent between winning and not competing, 1 strictly prefers to win and can do so. Thus, jurisdiction 2 cannot host the MNE in equilibrium. ■

As with the enforcement technology differential, the jurisdiction with the wage advantage will win the MNE. Finally, note that if jurisdiction i has both of these advantages over the other host, then it will win in equilibrium.

4 Joint Policy Formation

In this section, we introduce a federal government who takes into account the joint welfare of the two competing jurisdictions and can set the IPR and tax policies in both locations. We do so to examine the impact of joint policy formation (such as what the US has urged China to implement) for the jurisdictions and the MNE.

To this end, consider a federal policy maker who seeks to maximize the sum of expected indirect utility across the two locations which, when the MNE locates in jurisdiction i, is:

$$2\left(\left(1-\phi_i\left(g_i\right)\right)C\left(p_i\right)+\phi_i\left(g_i\right)C\left(w_i\right)\right)-g_1-g_2+t_i\pi_i^E\left(g_i\right)+w_1L_1+w_2L_2. \tag{25}$$

Note that in this, we drop the subscripts on $C\left(.\right)$ since consumers are identical and it is not necessary to continue distinguishing across the utility accruing to a given jurisdiction. Alternatively the federal government can allow the firm to remain at home, resulting in indirect utility of $2C\left(p_h\right)+w_1L_1+w_2L_2$.

In order to attract the MNE, the federal government chooses the four policy instruments (t_1, t_2, g_1, and g_2) to maximize aggregate indirect utility subject to the constraint that the firm must earn after tax profits in i of at least $\left(1-t_h\right)\pi_h$. As before, since indirect utility is strictly increasing in tax revenues, this constraint will bind. When jurisdiction i is the preferred location, $g_{-i}=0$ since these expenses are purely wasteful. Further, to guarantee that the MNE chooses i, the federal government can simply set $t_{-i}=1$. Thus, the problem reduces to choosing g_i and t_i, taking into account the MNE's outside option.

This results in the federal government choosing an IPR expenditure in i, g_i^f, which is determined by:

$$2\phi_i'\left(g_i^f\right)\left\{C_i\left(w_i\right)-C_i\left(p_i\right)\right\}-1=\phi_i'\left(g_i^f\right)\left(p_i-w_i\right)X\left(p_i\right). \tag{26}$$

Comparing this to what jurisdiction i chooses under competition (Equation 10), it is easy to see that this is a lower level of protection than occurs if i wins in equilibrium. This is because although out of pocket cost and the increase in expected tax revenues are the same for the federal government and jurisdiction i, the gains from imitation are strictly greater for the federal government because it internalizes the benefits this brings to consumers in both locations. As a result, the firm is more likely to be imitated and $\pi_i^E\left(g_i^f\right)<\pi_i^E\left(g_i^*\right)$.

The centrally-chosen tax rate, meanwhile, leaves the MNE indifferent between coming to invest in i and remaining at home. This is:

$$t_i^f=1-\frac{\left(1-t_h\right)\pi_h}{\pi_i^E\left(g_i^f\right)}. \tag{27}$$

Compared to the tax rate i would use when not competing against $-i$, the federally-chosen tax is lower. This is because the firm is more likely to be imitated under the federally-chosen IPRs and must therefore be compensated for the added risk.

This comparison, however, presumes both that i wishes to host the MNE and that it is the only jurisdiction which does. Dropping this assumption creates three additional potential inefficiencies relative to the federal government's goals: whether to compete at all, whether the competition equilibrium results in the firm locating in i, and even when that occurs, how IPRs and taxes compare.

We start with the first of these. Recall that by Proposition 2 that there are situations in which a host will not even attempt to compete (Equation 14). This condition is a comparison between the cost of IPRs, expected tax revenues, and the gains from only local consumers from lower prices. The federal government, however, considers the gains to consumers in both jurisdictions. Thus, there are situations in which a jurisdiction will not seek to attract the MNE even though the federal government would prefer that it did.[17] Thus competition may be inefficient relative to joint policy formation due to potential non-investment.

Second, parameter constellations exist in which the firm locates in $-i$ under competition even when the federal government prefers that it invest in i. For the federal government to prefer investment in i, it must be that:

$$\pi_i^E\left(g_i^f\right) - g_i^f \geq 2\Delta C^f + \pi_{-i}^E\left(g_{-i}^f\right) - g_{-i}^f \tag{28}$$

where g_{-i}^f is the IPR the federal government would choose conditional on investment in $-i$ and $\Delta C^f = \left(1-\phi_{-i}\left(g_{-i}^f\right)\right)C\left(p_{-i}\right) + \phi_{-i}\left(g_{-i}^f\right)C\left(w_{-i}\right) - \left(1-\phi_i\left(g_i^f\right)\right)C\left(p_i\right) + \phi_i\left(g_i^f\right)C\left(w_i\right)$ is comparable to ΔC but evaluated at the IPR expenditures the federal government would choose. That said, i will only win the MNE with competition when:

$$\pi_i^E\left(g_i^*\right) - g_i^* \geq \pi_{-i}^E\left(g_{-i}^*\right) - g_{-i}^* \tag{29}$$

which, depending on the parameters chosen, need not hold even if Equation 28 does. There are, however, three cases where this source of inefficiency can be ruled out. The first is trivial: when the jurisdictions are identical. The second is when, comparable to Lemma 1, wages are equal but jurisdiction 1 has lower cost IPR enforcement. In this case, since any outcome in 2 can be mimicked in 1 while spending less on IPR enforcement, the MNE locates in 1 both under competition and joint policy formation. Third, if IPR costs are identical but jurisdiction 1 has lower wages as in Lemma 2, 1 is both the federal government's preferred location as well as the one that wins under competition.

This does not, however, mean that even in these special cases that the equilibrium is efficient since, as noted above, the federal government would pick a lower IPR level than the winning jurisdiction would (note that comparison across IPR levels is the same since the IPR chosen by i is the same regardless of whether it competes for the MNE or simply must attract it from home). To complete our comparison, it is necessary to compare expected tax revenues under competition and joint policy formation. Note that we compare revenues, not tax rates. This is because, with different IPR levels, tax bases differ, meaning that the benefit of taxation (the revenues generated) is not solely determined by the tax rate.

When there is no actual competition as in Proposition 2, the hosting jurisdiction leaves the firm with profits equal to those in its outside option, $\left(1-t_h\right)\pi_h$. This is also what the MNE earns with joint policy formation. With competition, jurisdictions bid up the surplus accruing to the firm in an effort to attract it, meaning that the firm gains because its outside option rises above the after-tax profit it would earn were it to remain at home. This suggests that tax revenues are higher under joint policy formation than competition. However, it must

[17] This can be easily shown by taking Equation 14 and doubling the consumer surplus terms. If that increase is sufficiently large, even holding the IPR level at that the jurisdiction would choose unilaterally, then since that second-best value of hosting would lead the federal government to attract the firm even as the jurisdiction would not, this demonstrates the claim.

be remembered that expected tax revenues are the difference between pre-tax profits in the host ($\pi_i^E(g_i)$) and the amount the firm retains. Since $g_i^F < g_i^*$ and imitation is more likely under joint policy formation, $\pi_i^E\left(g_i^f\right) < \pi_i^E(g_i^*)$. Thus, even when the federal government's preferred location hosts with competition, it is ambiguous whether expected tax revenues are higher or lower under joint policy formation as they will depend on the difference in IPR levels. Nevertheless, due to the higher IPR levels under competition, joint policy formation yields higher aggregate expected indirect utility.

Lemma 3 *Due to lower equilibrium levels of IPR expenditures under joint policy formation in comparison to competition, aggregate expected indirect utility is higher under joint policy formation even as expected profits to the MNE are lower.*

This result compares fully centralized policies with fully decentralized ones. It is natural to then consider partial centralization, i.e. where the federal government sets taxes or IPRs. If it sets a single policy instrument but can allow it to vary across locations, the federal government can simply force out its less desired location by setting its tax equal to 1 or its IPR enforcement to zero. We therefore focus our attention to where taxes or IPRs must be the same across locations.

If the federal government instead imposes a common tax rate but allows jurisdictions to compete in IPRs, a comparable comparison to the above is found. When IPRs are set locally but the federal government chooses a common tax rate, it will again set a tax rate such that the firm is indifferent between locating in the winning jurisdiction (which when wages are equal will be the location where IPRs are less costly) and remaining at home. Thus, this is equivalent to full coordination from the perspective of the MNE. Aggregate expected indirect utility, however, is lower because both jurisdictions now invest in IPRs (rather than just the host) and because, as above, the IPRs they choose do not account for consumers in the other jurisdiction.

The MNE, however, may prefer coordination on IPRs alone. To see this, suppose that the federal government sets a common IPR protection level, $\tilde{\phi}$, which both locations must achieve. Note that if the IPR functions $\phi(.)$ differ then the cost of meeting this target will differ across them (denote these as $\tilde{g}_1$ and $\tilde{g}_2$). This policy will result in lower IPRs than arises with full competition because the federal government considers the gain from imitation to all consumers. Jurisdictions, meanwhile, compete only in taxes which again are bid down to a level where the loser is indifferent between winning and not hosting at all. A key difference between this and full competition, however, is that the cost of IPRs do not influence decisions because they must be paid in any case and would fall out of the equivalent of Equation 18. As such, the profits that accrue to the MNE are $\pi_2^E(\tilde{g}_2) + \Delta\tilde{C}$ where $\Delta\tilde{C}$ is comparable to ΔC except that all ϕs equal $\tilde{\phi}$. Assuming that 1 wins with competition, subtracting expected profits from the partial coordination case from those under competition (Equation 23) results in:

$$\left(\tilde{\phi} - \phi_2\left(g_2^*\right)\right)(p_2 - w_2)\,X(p_2) - g_2^* + \Delta C - \Delta\tilde{C} \tag{30}$$

which is in general ambiguous. The first term is positive since competition leads to greater enforcement. The second is negative and represents that 2 can avoid IPR expenditures under competition by ceding the MNE. The differential consumer surplus gain from hosting is

embodied by $\Delta C - \Delta\tilde{C}$ which depends on wage differentials, the cost of IPR differentials (and thus the probability of imitation under competition), and the difference between $\tilde{\phi}$ and the probabilities arising under competition. Even when jurisdictions are identical, so that $\Delta\tilde{C} = \Delta C = 0$, this remains ambiguous and depends on the degree of difference between the imitation probabilities. Thus, the MNE may again prefer full competition if this implies significantly higher IPR protection. Nevertheless, since this outcome could be achieved under full coordination, aggregate expected indirect utility cannot rise.

Note that an implication of this is that the MNE (and thus presumably its home government) often prefers competition to joint policy formation. This is both because competition leads to greater IPR protection and because it shifts policies in a way that increases expected after-tax profits. Therefore, even though the MNE's home government may lament the level of IPRs as too low under competition compared to the level it would most prefer, asking the host federal government to coordinate policies is unlikely to improve its situation. This can therefore help to explain the initial posturing and subsequent retreat of the US in its negotiations with China.

A final, and important, caveat to our analysis is that in it, we take the existence of the MNE's product as given. As is clear, if a firm anticipates imitation, it may be less likely to invest in risky R&D in the first place. Our results would nonetheless still suggest that, because a central government recognizes the impact on all its consumers instead of just those in one location, that it would still tend towards weaker IPRs than arise with competition even when innovation is endogenous.

5 Conclusion

Motivated by recent rhetoric in policy circles, this paper presents the first model of competition in both taxes and IPRs for mobile investment. Considering both of these policies at once is important since, if weak IPRs lead to imitation and lower tax bases, this has implications for taxation. Indeed, we find that governments are forced to offer lower taxes to compensate for weaker IPRs. In equilibrium, our model suggests that, relative to joint policy formation, unbridled competition has multiple potential sources of inefficiency from the potential hosts' perspectives. Among these is that since a local policy maker does not account for the impact of prices on other jurisdictions, that they will tend to set IPRs higher than a coordinated policy would dictate. In addition, as is standard, taxes will be competed downwards in order to attract the MNE to a given location. Thus, a MNE can actually lose profits if it argues for the elimination of competition in IPRs across locations in favor of a centrally-determined policy. This can provide grounds for why the US initially lambasted China for permitting weak IPRs in some provinces, gaining headlines and potential votes, before dropping the issue in actual trade negotiations. In addition, it shows an additional conflict between the interests of developing and developed countries when it comes to IPR enforcement, harkening to the debate over the TRIPS provision of the WTO. With the emergence of the novel coronavirus in 2020 bringing issues of FDI and MNE's intellectual properties in the medical sector to the forefront of international discussions – alongside concerns regarding the taxation (or lack thereof) of FDI – we hope that our results provide useful insights for current debates.

Figure 1: Days for contract enforcement (2016)

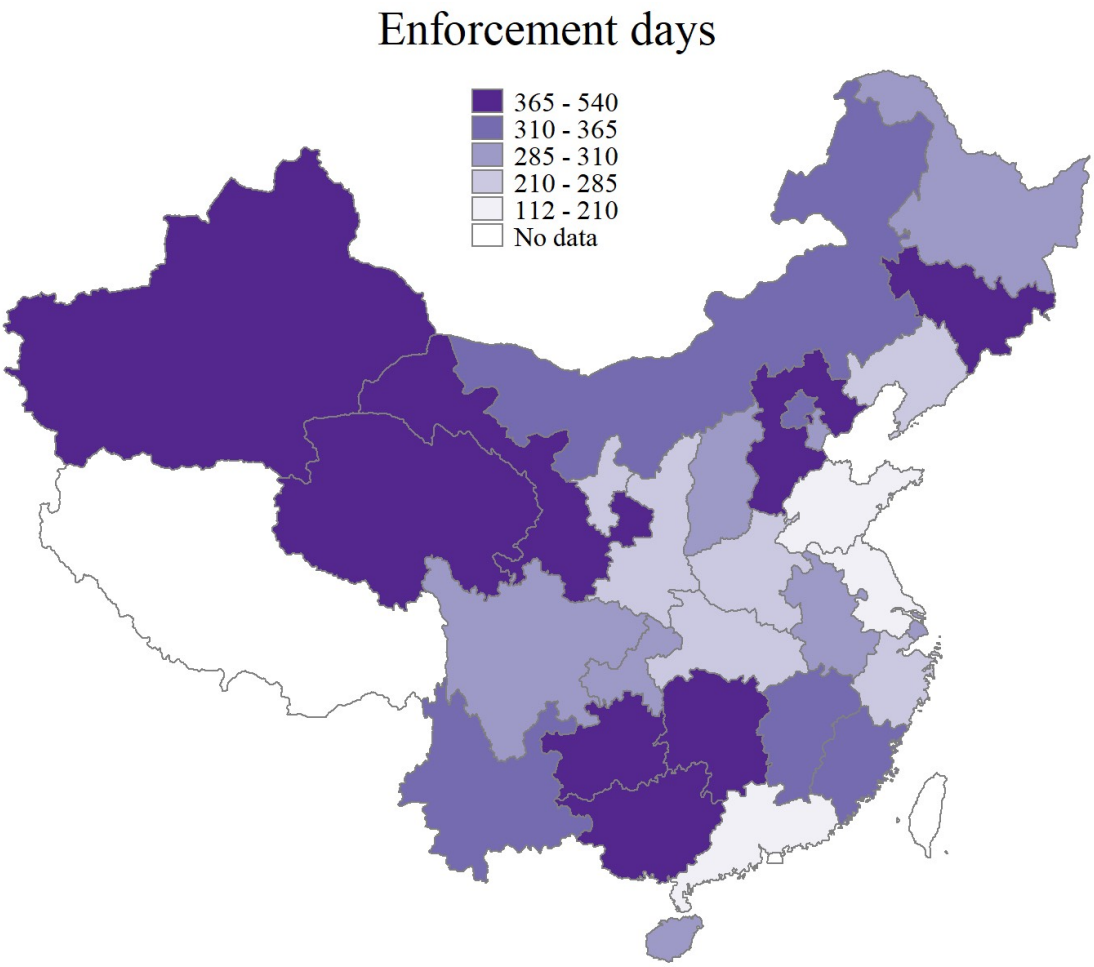
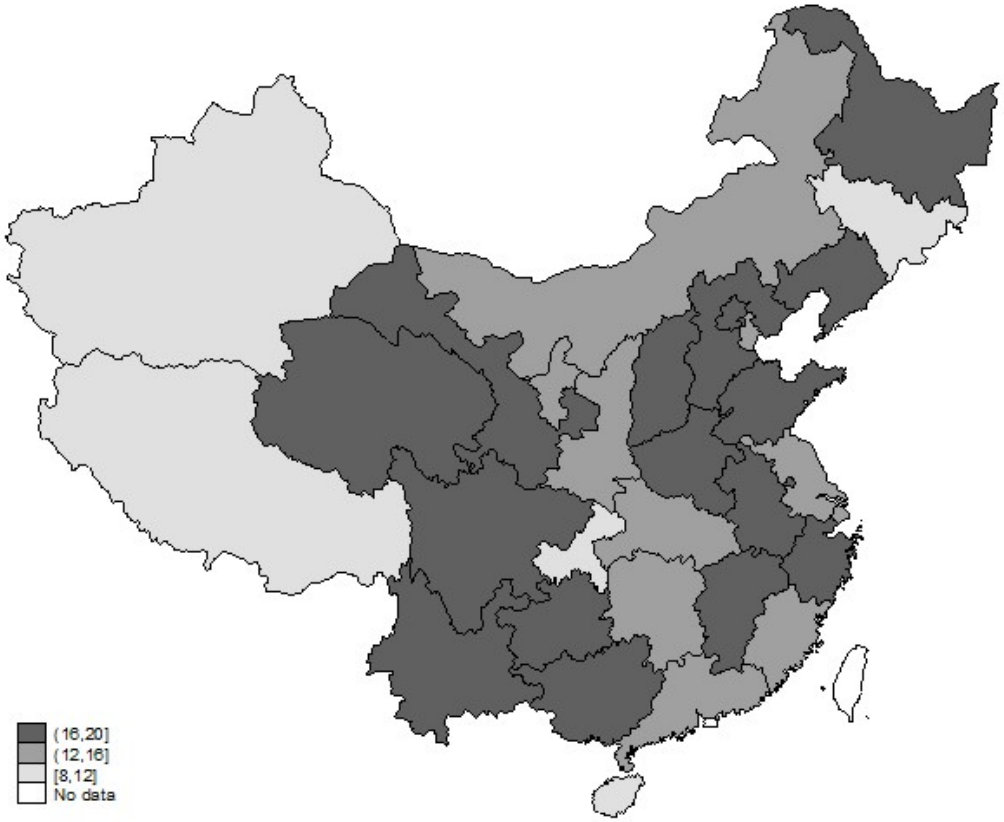


Figure 2: Weighted average of effective corporate income tax rates across provinces (1998-2013)



References

[1] Behrens, K. and Picard, P.M. (2008). Bidding for horizontal multinationals, Journal of the European Economic Association, 6, 1244-1278.

[2] Bjorvatn, K. and Eckel, C. (2006). Policy competition for foreign direct investment between asymmetric countries, European Economic Review, 50, 1891-1907.

[3] Black, D.A. and Hoyt, W.H. (1989). Bidding for firms, American Economic Review, 79, 1249-1256.

[4] Braga, C.A. and Fink, C. (1998). The relationship between intellectual property rights and foreign direct investment, Duke Journal of Comparative and International Law, 9, 163-188.

[5] Branstetter, L., Fisman, R. and Foley, C. (2006). Do stronger intellectual property rights increase international technology transfer? Empirical evidence from US firm-level panel data, Quarterly Journal of Economics, 121, 321-349.

[6] Branstetter, L.G., Fisman, R., Foley, F.C., and Saggi, K. (2010). Does intellectual property rights reform spur industrial development? Journal of International Economics, 83, 97-112.

[7] Branstetter, L. and Saggi, K. (2011). Intellectual property rights, foreign direct investment and industrial development, Economic Journal, 121, 1161-1191.

[8] Chen, Y. and Puttitanun, T. (2005). Intellectual property rights and innovation in developing countries, Journal of Development Economics, 78, 474-493.

[9] Chen, J. Pan X, Qian M, and Wu Y. (2018). Does property rights protection affect firm innovation? Evidence from the Chinese property rights law enactment, Working Paper, Australian National University, Canberra.

[10] Davies, R.B. (2005). State tax competition for foreign direct investment: a winnable war? Journal of International Economics, 67, 498-512

[11] Davies, R.B. and Naughton, H. (2014). International cooperation in environmental policy: A spatial approach, International Tax and Public Finance, 21(5), 923-954.

[12] Davies, R.B. and Vadlamannati, K. (2013). A Race to the bottom in labour standards? An empirical investigation, Journal of Development Economics, 103(1), 1-14.

[13] Davies, R.B. and Ellis, C.J. (2007). Competition in Taxes and Performance Requirements for Foreign Direct Investment, European Economic Review, 51(6), 1423-1442.

[14] Davies, R.B. and Markusen, J.R. (forthcoming). The structure of multinational firms' international activities, in F. Foley, J.R. Hines, and D. Wessel (eds.), Multinational Corporations in a Changing Economy, Washington D.C.: Brookings.

[15] Dewit, G., K. Hynes and Leahy, D. (2018). Corporate tax games with cross-border externalities from public infrastructure, Economic Inquiry, 56(2), 1047-1063.

[16] Ferrett, B. and Wooton, I. (2010). Competing for a duopoly: international trade and tax competition, Canadian Journal of Economics, 43(3), 776-794.

[17] Fumagalli, C. (2003). On the welfare effects of competition for foreign direct investments, European Economic Review, 47, 963-983

[18] Glass, A.J. and Saggi, K. (2002). Intellectual property rights and foreign direct investment, Journal of International Economics, 56(2), 387-410.

[19] Glass, A.J. and Wu, X. (2007). Intellectual property rights and quality improvement, Journal of Development Economics, 82(2), 393-415.

[20] Grossman, G.M. and Helpman, E. (1991a). Innovation and Growth in the Global Economy, Cambridge: MIT press.

[21] Grossman, G.M. and Helpman, E. (1991b). Endogenous product cycles, Economic Journal, 101(3), 1214-29.

[22] Han, Y., Pieretti, P. and Zou, B. (2017). On the desirability of tax coordination when countries compete in taxes and infrastructure, Economic Inquiry, 55, 682-694.

[23] Haufler, A. and Wooton, I. (1999). Country size and tax competition for foreign direct investment, Journal of Public Economics, 71(1), 121-139.

[24] Haufler, A. and Wooton, I. (2006). The effects of regional tax and subsidy coordination on foreign direct investment, European Economic Review, 50(2), 285-305.

[25] Haufer, A., P.J. Norbck and Persson, L. (2014). Entrepreneurial innovations and taxation, Journal of Public Economics, 113, 13-31.

[26] Helpman, E. (1993). Innovation, imitation, and intellectual property rights, Econometrica, 61(6), 1247-80.

[27] Hynes, K., Ma, J. and Yuan, C. (2019). Transport infrastructure investment and competition for FDI, Scottish Journal of Political Economy, 66(4), 511-526.

[28] Javorcik, B.S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages, American Economic Review, 94, No. 3, 605-27.

[29] Lai, E. (1998). International intellectual property rights protection and the rate of product innovation, Journal of Development Economics, 55(1), 133-53.

[30] Lee, J. and Mansfield, E. (1996). Intellectual property protection and U.S. foreign direct investment, The Review of Economics and Statistics, 78(2), 181-186.

[31] Liu, Y. and Martinez-Vazquez, J. (2014). Interjurisdictional tax competition in China, Journal of Regional Science, 54(4), 606-628.

[32] Massey, J.A. (2006). Emperor is far away: China's enforcement of intellectual property rights protection, 1986-2006, Chicago Journal of International Law, 7(1) 231-235.

[33] McCalman, P. (2004). Foreign direct investment and intellectual property rights: Evidence from Hollywood;s global distribution of movies and videos, Journal of International Economics, 62, 107-123.

[34] Nunnenkamp, P. and Spatz, J. (2004). Intellectual property rights and foreign direct investment: A disaggregated analysis, Review of World Economics, 140(3), 292-414.

[35] Ottaviano, G. and van Ypersele, T. (2005). Market size and tax competition, Journal of International Economics 67, 25-46.

[36] Smith, P. J. (2001). How do foreign patent rights affect U.S. exports, affiliate sales, and licenses? Journal of International Economics, 55(2), 411-439.

[37] Tanaka, H. and Iwaisako, T. (2014). Intellectual property rights and foreign direct investment: A welfare analysis, European Economic Review, 67, 107-124.

[38] United States Trade Representative (2019). Special 301 Report, April 2019, Washington D.C.: USTR.

UCD CENTRE FOR ECONOMIC RESEARCH – RECENT WORKING PAPERS

WP19/27 Dimitrios Bermperoglou, Yota Deli and Sarantis Kalyvitis: 'Investment Tax Incentives and Their Big Time-to-Build Fiscal Multiplier' November 2019
WP19/28 Judith M Delaney and Paul J Devereux: 'Math Matters! The Importance of Mathematical and Verbal Skills for Degree Performance' November 2019
WP19/29 Alan Fernihough and Cormac Ó Gráda: 'Across the Sea to Ireland: Return Atlantic Migration before the First World War' November 2019
WP19/30 Tamanna Adhikari and Karl Whelan: 'Do Business-Friendly Reforms Boost GDP?' December 2019
WP19/31 Judith M Delaney and Paul J Devereux: 'The Effect of High School Rank in English and Math on College Major Choice' December 2019
WP19/32 Tensay Hadush Meles, Lisa Ryan and Sanghamitra Mukherjee: 'Heterogeneity in Preferences for Renewable Home Heating Systems' December 2019
WP20/01 Cormac Ó Gráda: 'Economic History: 'An Isthmus Joining Two Great Continents'?' January 2020
WP20/02 Margaret Samahita and Håkan J Holm: 'Mining for Mood Effect in the Field' January 2020
WP20/03 Vincent Hogan and Patrick Massey: 'Professional Rugby on the Celtic Fringe' January 2020
WP20/04 Sanghamitra Chattopadhyay Mukherjee, Séin Healy, Tensay Hadush Meles, Lisa Ryan, Robert Mooney, Lindsay Sharpe and Paul Hayes: 'Renewable Energy Technology Uptake: Public Preferences and Policy Design in Early Adoption' February 2020
WP20/05 Ronald B Davies and James R Markusen: 'The Structure of Multinational Firms' International Activities' February 2020
WP20/06 Morgan Kelly: 'Direct Standard Errors for Regressions with Spatially Autocorrelated Residuals' March 2020
WP20/07 Anna Bayona and Oana Peia: 'Financial Contagion and the Wealth Effect: An Experimental Study' March 2020
WP20/08 Orla Doyle: 'Can Early Intervention have a Sustained Effect on Human Capital?' April 2020
WP20/09 Supriya Kapoor and Oana Peia: 'The Impact of Quantitative Easing on Liquidity Creation' April 2020
WP20/10 Judith M Delaney and Paul J Devereux: 'Choosing Differently? College Application Behaviour and the Persistence of Educational Advantage' May 2020
WP20/11 Jonathan Briody: 'Parental Unemployment During the Great Recession and Childhood Adiposity' May 2020
WP20/12 Tensay Meles, Lisa Ryan, and Joe Wheatley: 'COVID-19 and EU Climate Targets: Going Further with Less?' May 2020
WP20/13 Xidong Guo and Sarah Parlane: 'Addressing Private Practice in Public Hospitals' May 2020
WP20/14 Patrick Massey and Moore McDowell: 'EU Competition Law: An Unaffordable Luxury in Times of Crisis?' May 2020
WP20/15 Judith M Delaney and Paul J Devereux: 'How Gender and Prior Disadvantage predict performance in College' May 2020
WP20/16 Morgan Kelly, Joel Mokyr and Cormac Ó Gráda: 'The Mechanics of the Industrial Revolution' June 2020
WP20/17 Morgan Kelly and Cormac Ó Gráda: 'Connecting the Scientific and Industrial Revolutions: The Role of Practical Mathematics' June 2020
WP20/18 Ronald B Davies, Dieter F Kogler and Ryan Hynes: 'Patent Boxes and the Success Rate of Applications' June 2020

UCD Centre for Economic Research
Email economics@ucd.ie