# Intellectual Property Rights, Imitation, and Foreign Direct Investment: Theory and Evidence*

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October 26, 2005

**Abstract**

Does the adoption of stronger intellectual property rights in developing countries enhance or retard their industrial development? How does such a policy shift affect industrial activity in the developed countries, where most innovative activity is concentrated? We address these questions both theoretically and empirically. On the theoretical side, we develop a North-South product cycle model in which Northern innovation, Southern imitation, and FDI are all endogenous. This model predicts that IPR reform in the South leads to increased FDI from the North, as Northern firms shift production to Southern affiliates. This increased FDI drives an acceleration of Southern industrial development, as the South's share of global manufacturing and the pace at which production of more recently invented goods shifts to the South both increase. The model also predicts that as production shifts to the South, Northern resources will be reallocated to R&D, driving an increase in the global rate of innovation. We confront the theoretical model with evidence on the response of U.S. multinationals to a series of well-documented IPR reforms by developing countries in the 1980s and 1990s. Our results indicate that U.S.-based MNCs expand

*The statistical analysis of firm-level data on U.S. multinational enterprises was conducted at the International Investment Division of the Bureau of Economic Analysis, U.S. Department of Commerce under arrangements that maintain legal confidentiality arrangements. The views expressed herein are those of the authors and do not reflect official positions of the U.S. Department of Commerce. We wish to thank Pol Antràs, Amy Glass, Fuat Sener, and seminar participants at Columbia University for helpful comments. We are grateful to Yoshiaki Ogura and Sergei Koulayev for excellent research assistance and to the National Science Foundation for financial support.

the scale of their activities in reforming countries after IPR reform, and this effect is disproportionately strong for affiliates whose parents rely strongly on patented intellectual property as part of their global business strategy. Data tracking industry level value-added in the reforming countries point to an overall expansion of industrial activity after IPR reform. Finally, evidence from highly disaggregated trade data also suggests that the expansion of multinational activity leads to a higher net level of production shifting to developing countries, more than offsetting any possible decline in the imitative activity of indigenous firms.

# 1 Introduction

How do reforms aimed at strengthening intellectual property rights (IPR) impact industrial development in reforming countries and in the global economy as a whole? It is well known that the effective enforcement of IPR confers monopoly power on the creators of intellectual property, generating a static welfare loss. In addition, opponents of the recent shift to stronger IPR enforcement in developing countries are concerned that such a policy shift will hamper the ability of local firms to experiment with and assimilate advanced foreign technologies at low cost (i.e. it may slow down the process of international technology diffusion).[1] For example, a critic of stronger IPR enforcement in developing countries may argue that the rapid postwar industrialization in East Asian countries such as Japan and South Korea was achieved under relatively weak IPR regimes and that a premature imposition of a strong IPR regime could retard the industrial development of today's developing countries.[2] On the other hand, proponents of stronger IPR argue that improvements in IPR may actually enhance the industrial development process in developing countries. At the crux of their argument is the idea that the provision of greater security for intellectual property in developing countries will encourage multinationals to shift production to such countries. This argument implies that the decline in indigenous imitative activity in developing countries that institute IPR reforms can, in principle, be offset by increased multinational activity. Furthermore, propo-

[1] Goto (2003) suggests that features of the postwar Japanese patent system may have enhanced the ”catch-up” process. Chang (2002) argues that the ”developing countries” of the 19th century, including the U.S., benefitted from incomplete IPR regimes in a similar way.

[2] See Maskus (2000), who notes these arguments, and the overview and evidence presented in Ordover (1991) and Maskus and McDaniel (1999). On South Korea, see Westphal, Kim, and Dahlman (1985).

nents also argue that stronger IPR enforcement in developing countries will lead to increased world wide innovation, benefitting consumers everywhere. This paper seeks to illuminate the debate between these two views by deriving and empirically testing the effects of increased Southern IPR protection on Southern industrial development in a North-South product cycle model of international trade and foreign direct investment (FDI).

This model extends the work of Helpman (1993) and Lai (1998). Helpman (1993) develops a two region (North-South) general equilibrium framework in which all innovation takes place in the North, precluding any benefit resulting from increased innovation in the South as a consequence of stronger IPR. Subsequent work has retained this assumption; to maximize continuity with this earlier work, so do we.[3] In Helpman's model, stronger IPR in the South significantly retards Southern industrial development. The share of global manufacturing undertaken in the South is lower in the strong IPR equilibrium, and the rate at which the production of recently invented goods shifts to the South declines, worsening Southern terms of trade. Stronger IPR expands the North's share of global manufacturing – at the expense of the South – but causes the rate of innovation in the North to decline in the long run, relative to the weak IPR equilibrium, because more Northern resources are tied up in production rather than innovation. In other words, the retardation of Southern industrial development also leads to a decline in the rate of Northern innovation. Helpman goes on to conduct an explicit welfare analysis, demonstrating that the negative effects of stronger IPR on Southern industrial development and on the global rate of innovation contribute to an overall negative welfare effect of stronger IPR on the South. Even in the North, the decline in the rate of innovation can offset static welfare gains. Helpman's analysis demonstrated that the effect of stronger IPR on Southern industrial development is a crucial determinant of its overall impact on the global economy.

We extend Helpman (1993) in two critical ways. First, we allow the level of FDI in the South to respond endogenously to changes in the strength of Southern IPR protection. As Lai (1998) has shown, allowing for this kind of endogenous response can lead to a reversal of the prediction that stronger IPR in the South retards Southern industrial development.[4] Instead, North-

[3]The empirical evidence that stronger IPR leads to significantly more indigenous innovative activity is mixed at best. The results of Lerner (2002), Branstetter, Fisman, and Foley (forthcoming), Scherer and Weisburst (1995), and Sakakibara and Branstetter (2001) all suggest weak effects.

[4]When Helpman (1993) extends his model to allow for FDI, he does so under the assumption that both innovation and imitation are exogenous and that the same risk of

ern MNCs respond to stronger IPR in the South by shifting production to their Southern affiliates, allowing for a reallocation of Northern resources away from production and toward innovative activity. Although Southern imitation declines, this decline is more than offset by the increased activity of multinational firms. The share of global manufacturing undertaken in the South expands and the pace at which production of recently invented goods shifts to the South accelerates, leading to an overall enhancement of Southern industrial development. Under this scenario, the global rate of innovation and new product introduction also increase, potentially generating global welfare gains.

Second, like Grossman and Helpman (1991b), we treat imitation as a costly activity and allow the level of imitative effort by Southern firms to be endogenously determined.[5] Making both imitation and FDI endogenous increases complexity, but these features allow us to make a contribution to the development of richer North-South product cycle models of international trade. More importantly, since imitation is indeed a costly activity in the real world, analyses of IPR protection that treat it as exogenous fail to account for the fact that IPR reforms alter the global allocation of resources among imitation and other economic activities. This resource reallocation has welfare consequences for both the North and the South. In our model, stronger IPR protection in the South slows down imitation, thereby freeing up local resources that are utilized by multinational firms, which are attracted to the South in greater numbers due to a reduction in the Southern risk of imitation. Even though stronger IPR protection results in fewer imitated goods being produced in the South, overall Southern industrial development is enhanced under reasonable parameterizations because the increase in FDI from the North to the South more than offsets the reduction in the extent of Southern imitation.

We confront the predictions of our model with a variety of empirical tests that assess its validity as a descriptive tool. In order to investigate the impact of IPR reform on multinational production in the South, we begin by analyzing the response of U.S. multinationals to a series of well-documented IPR reforms by sixteen countries in the 1980s and 1990s. Consistent with the model, we find that U.S.-based multinationals expand the scale of their

imitation applies to Northern firms and multinationals.

[5]Helpman (1993) encouraged the incorporation of this feature into models like his own. He noted that "...imitation is an economic activity much the same as innovation; it requires resources and it responds to economic incentives..." and that "...in order to take account of these considerations there is need for considerable extension of the models employed in this paper."

activities in reforming countries after IPR reform. Local affiliate output, employment levels, and capital stocks expand significantly after reform, and this effect is particularly strong for affiliates whose parents make extensive use of the patent system in the U.S. Specifications based on those presented in Branstetter, Fisman, and Foley (forthcoming) demonstrate that the technological intensity of affiliates of patent-intensive parent firms rises significantly after IPR reform. This evidence is consistent with U.S. multinationals shifting production of more technologically intensive goods to affiliates in reforming countries in response to IPR reform.

It is more difficult to assess changes in the rate of imitation by indigenous firms. Using U.N. industry-level data from reforming countries, we show that industry-level value added increases after reforms, particularly in those industries that are technology-intensive and where U.S. FDI is concentrated. This suggests that increased multinational activity is sufficiently large to offset potential declines in imitative local activity, thereby leading to an overall enhancement of Southern industrial development. This is important, since theory suggests that IPR reform must enhance Southern industrial development if it is to be welfare improving. Further indirect evidence on the rate at which production of goods is transferred to reforming countries is obtained by analyzing disaggregated U.S. import statistics. Following Feenstra and Rose (2000), we construct for each reforming country an annual count of "initial export episodes" – the number of 10-digit commodities for which recorded U.S. imports from a given country exceed zero for the first time. This is used as a rough indicator of the rate at which production of goods shifts to the reforming countries, through a combination of multinational production and indigenous imitation. Tests indicate that this rate of production transfer increases sharply after IPR reform, suggesting that any decline in indigenous innovation is more than offset by an expanded range of goods being produced through multinational affiliates. Again, the evidence suggests that IPR reform enhances, rather than retards, Southern industrial development.

Recent empirical attempts to assess the welfare impact of stronger IPR in developing countries, such as Chaudhuri and Goldberg (2004), Fink (2000), and McCalman (2001) focus on the short-run effects of higher patent-protected product prices on consumers, while ignoring or heavily discounting the possible effects of such reform on the global allocation of production, Southern industrial development, and longer-run trends in global innovation and growth. Product cycle models in the Grossman-Helpman tradition highlight the existence of channels through which stronger IPR could raise welfare. Among the most important of these channels is the impact of IPR on Southern industrial development. Any attempt to assess the welfare impact of the recent move to stronger IPR in developing countries will be seriously incomplete until economists attempt to assess the extent to which these mechanisms, highlighted by theory, operate in practice. That is the goal of this paper.

# 2 Theory

In what follows, we present our North-South product cycle model. Our model borrows from the work of Grossman and Helpman (1991b), Helpman (1993), and Lai (1998), but it also builds on this theoretical foundation in substantive ways.[6] The primary goal of our theoretical exercise is to derive the effect of an increase in Southern IPR protection on Southern industrial development and the international allocation of production when innovation, FDI, and imitation are all endogenous. We demonstrate that an increase in Southern IPR protection leads to a decrease in Southern imitation but an increase in the degree to which Northern multinationals shift production to their Southern affiliates. Under a wide range of plausible parameter values, we can show that the second effect dominates; on net, stronger IPR accelerates the rate at which goods shift to the South and expands the South's share of global manufacturing. Thus, the model generates a clear, empirically testable hypothesis that can then be taken to the data. Readers who are primarily interested in our empirical results may wish to move to section 3.

## 2.1 A North-South Model with FDI

There are two regions (North and South). Labor is the only factor of production and region $i$'s labor endowment equals $L^i$, $i = N, S$. As in Grossman and Helpman (1991a), preferences are identical in the two regions and a representative consumer chooses instantaneous expenditure $E(\tau)$ to maximize utility at time $t$:

$$U = \int_t^\infty e^{-\rho(\tau - t)} \log D(\tau) d\tau \tag{1}$$

[6]Following Helpman (1993) and Lai (1998), our model focuses on the transfer of production within multinational firms. For analyses of the tradeoff between FDI and arm's length technology licensing in a product cycle framework, see Antràs (2005), Glass and Saggi (2002b), and Yang and Maskus (2001). For models that focus on strategic and contractual elements underlying the choice between licensing and FDI see Ethier (1986), Ethier and Markusen (1996) and Markusen (2001).

subject to the intertemporal budget constraint

$$\int_t^{\infty} e^{-r(\tau-t)}E(\tau)d\tau = \int_t^{\infty} e^{-r(\tau-t)}I(\tau)d\tau + A(t) \text{ for all } t \tag{2}$$

where $\rho$ denotes the rate of time preference; $r$ the nominal interest rate; $I(\tau)$ instantaneous income; and $A(t)$ the current value of assets. The instantaneous utility $D(\tau)$ is given by

$$D = \left[\int_0^n x(j)^{\alpha} dj\right]^{\frac{1}{\alpha}} \tag{3}$$

where $x(j)$ denotes the consumption of good $j$; $n$ the number of goods available and $0 < \alpha < 1$.

As is well known, under the above assumptions, the consumer's optimization problem can be broken down into two stages. First, it chooses how to allocate a given spending level across all available goods. Second, it chooses the optimal time path of spending. Equation (3) implies that the elasticity of substitution between any two goods is constant and equals $\varepsilon = \frac{1}{1-\alpha}$ and demand for good $j$ (given expenditure $E$) is given by

$$x(j) = \frac{Ep(j)^{-\varepsilon}}{P^{1-\varepsilon}} \tag{4}$$

where $p(j)$ denotes the price of good $j$ and $P$ a price index such that

$$P = \left[\int_0^n p(j)^{1-\varepsilon} dj\right]^{\frac{1}{1-\varepsilon}} \tag{5}$$

Furthermore, under the two-stage procedure, the optimal spending rule is given by

$$\frac{\dot{E}}{E} = r - \rho \tag{6}$$

Following Grossman and Helpman (1991b), if we normalize by $E(t) = 1$ for all $t$ then in steady state we have $r(t) = \rho$.

### 2.1.1 Product Market

Three types of firms produce goods: Northern firms ($N$), Northern multinationals ($M$), and Southern imitators ($S$). Denote firms by $J$ where $J = N$, $M$, or $S$. Northern firms can either produce in the North or the South. They need one worker to produce a unit of output in the North whereas

$\theta \geq 1$ workers per unit of output are needed in the South. This assumption is based on the theory of the multinational firm which argues that such firms need advantages based on superior technology and management to offset the fact that they have to coordinate decisions over large distances and operate in an environment with which they are less familiar relative to local firms (see Markusen, 1995).

Given the demand function in (4), it is straightforward to show that prices of Northern firms are mark-ups over their marginal costs:

$$p^N = \frac{w^N}{\alpha} \text{ and } p^M = \frac{\theta w^S}{\alpha} \tag{7}$$

Southern firms can produce only those goods that they have successfully imitated and they need one worker to produce one unit of output. Let $\mu$ denote the rate of imitation (defined in equation 17) and as in Lai (1998) assume that imitation targets only Northern multinationals.[7] As is well known from the work of Mansfield (1994) and Maskus (2000), multinational firms internalize the risk of imitation that they face due to weak IPR protection in host countries. Of course, in the real world, Northern firms that do not undertake FDI can also have their technologies imitated but its likely that they face a risk of imitation that is lower than that faced by multinational firms that produce in the South. In our model, the risk faced by Northern firms that do not produce in the South has been normalized to zero.[8]

If successful in imitating a multinational, a Southern firm engages in price competition with the Northern multinational whose good it has copied so that in equilibrium we have:

$$p^S = \theta w^S \tag{8}$$

Note that limit pricing is optimal for a Southern imitator iff its unconstrained monopoly price $\frac{w^S}{\alpha}$ exceeds the multinational's marginal cost $\theta w^S$:

$$\theta w^S < \frac{w^S}{\alpha} \Leftrightarrow \theta < \frac{1}{\alpha}. \tag{9}$$

When $\theta\alpha > 1$, a Southern imitator charges the unconstrained monopoly price $\frac{w^S}{\alpha}$. In what follows, we focus on the case where $\theta\alpha < 1$.

[7] Findlay's (1978) model showed that the 'contagion' effect of FDI that leads to technology spillovers could be an important determinant of growth in the South.

[8] This assumption is made for modeling convenience. We can relax this assumption, allowing for a positive, fixed risk of imitation of Northern firms, and our theoretical results will still obtain.

Let $x^J$ denote the output level of firm $J$ where $J = N, M$, or $S$. We know from the demand equation (4) that

$$\frac{x(i)}{x(j)} = \frac{p_i^{-\varepsilon}}{p_j^{-\varepsilon}} \tag{10}$$

Using the pricing equations for the three types of products, we have

$$\frac{x^S}{x^M} = \alpha^{-\varepsilon} \tag{11}$$

and

$$\frac{x^M}{x^N} = \left[\frac{\theta w^S/\alpha}{w^N/\alpha}\right]^{-\varepsilon} = \left[\frac{\theta w^S}{w^N}\right]^{-\varepsilon} \tag{12}$$

Flow profit of a Northern producer are given by

$$\pi^N = (p^N - w^N)x^N = \frac{(1-\alpha)w^N x^N}{\alpha} \tag{13}$$

Similarly, a multinational's flow profit equals

$$\pi^M = (p^M - w^S)x^M = \frac{\theta(1-\alpha)w^S x^M}{\alpha} \tag{14}$$

while that of a Southern firm equals

$$\pi^S = (\theta w^S - w^S)x^S = (\theta - 1)w^S x^S \tag{15}$$

### 2.1.2 Innovation, Imitation, and FDI

Of the $n$ goods that exist, $n_N$ are produced in the North, $n_M$ are produced in the South by Northern multinationals, and $n_I$ are produced by Southern imitators. Let $n_S \equiv n_I + n_M$ denote all goods produced in the South and let the rate of FDI be defined by

$$\phi \equiv \frac{\dot{n_M}}{n_N} \tag{16}$$

where $n_N$ denotes the number of goods produced in the North. In other words, the stock of goods produced by multinational increases by $\phi n_N$ at each instant. Let the rate of imitation $\mu$ be defined by

$$\mu \equiv \frac{\dot{n_I}}{n_M} \tag{17}$$

i.e. $\mu$ denotes the rate of increase of imitated goods relative to the total number of goods produced by Northern multinationals. We can think of the level of Southern industrial development as roughly corresponding to the Southern share of global manufacturing; i.e., the ratio of goods produced in the South to the number of goods that exist at a point in time. Our concept of industrial development explicitly includes the activities of Northern affiliates. The advance of Southern industrial development will obviously depend on the rate of FDI and the rate of imitation. Like Lai (1998), we study a steady state equilibrium in which all product categories grow at the same rate $g$:

$$g \equiv \frac{\dot{n}}{n} = \frac{\dot{n_N}}{n_N} = \frac{\dot{n_I}}{n_I} = \frac{\dot{n_M}}{n_M} = \frac{\dot{n_S}}{n_S} \tag{18}$$

Using equations (16) through (18), we have

$$\frac{n_M}{n_N} = \frac{\phi}{g} \text{ and } \frac{n_S}{n_N} = \frac{\phi}{g}\left[1 + \frac{\mu}{g}\right] \tag{19}$$

Similarly,

$$\frac{n}{n_N} = 1 + \frac{\phi}{g}\left[1 + \frac{\mu}{g}\right] \text{ and } \frac{n_I}{n_M} = \frac{\mu}{g} \tag{20}$$

A successful Northern innovator has the option of producing either in the North or in the South. While it is cheaper to produce in the South (as we show below, the Southern relative wage is lower in equilibrium), shifting production to the South invites the risk of imitation. The lifetime value of a successful innovator who chooses to produce in the North equals:

$$v^N = \frac{\pi^N}{\rho + g} \tag{21}$$

while that of one that chooses to become a multinational equals

$$v^M = \frac{\pi^M}{\rho + \mu + g} \tag{22}$$

Since all Northern firms are free to become multinationals we must have

$$v^N = v^M \tag{23}$$

Similarly, the lifetime value of a Southern producer (i.e. the reward earned by a successful imitator) equals

$$v^S = \frac{\pi^S}{\rho + g} \tag{24}$$

#### 2.1.3 Relative Wage

Since $v^N = v^M$, we have

$$\frac{\pi^M}{\pi^N} = 1 + \frac{\mu}{\rho + g} \tag{25}$$

But from the definition of profit we have

$$\frac{\pi^M}{\pi^N} = \frac{\theta w^S x^M}{w^N x^N} = \left[\frac{\theta w^S}{w^N}\right]^{1-\varepsilon} \tag{26}$$

The last two equations define the Northern relative wage as a function of the rate of innovation and imitation as well as the other exogenous parameters of the model:

$$\frac{w^N}{w^S} = \theta \left[1 + \frac{\mu}{\rho + g}\right]^{\frac{1}{\varepsilon - 1}} \tag{27}$$

As is clear, the relative wage in the North increases with the production disadvantage faced by Northern multinationals ($\theta$) as well as with the Southern rate of imitation ($\mu$) since both these factors encourage Northern firms to produce in the North as opposed to the South (thereby increasing the relative demand for Northern labor). The relative wage can also be written as

$$\frac{w^N}{w^S} = \theta \left[\frac{n_S}{n_M}\right]^{\frac{1}{\varepsilon - 1}} \tag{28}$$

i.e. the larger the share of Southern production that is done by multinationals, the lower the relative wage in the North. This endogenous adjustment of relative wage implies that as the extent of Northern FDI increases, the incentive for further FDI is reduced.

#### 2.1.4 Free Entry

Free entry into innovation implies that the value of Northern firm must exactly equal the cost of innovation:

$$v^N = \frac{w^N a_N}{n} \Leftrightarrow \frac{\pi^N}{\rho + g} = \frac{w^N a_N}{n} \tag{29}$$

where $a_N$ is the unit labor requirement in innovation. The above formulation assumes that the cost of innovation falls with the number of products ($n$) that have been invented. In other words, knowledge spillovers from innovation sustain further innovation. This assumption is standard in the literature (see Grossman and Helpman, 1991a and b, and Romer, 1990) and in its absence growth cannot be sustained in the variety expansion model with fixed resources. The flow profit of a successful innovator declines with the number of products invented and incentives for innovation disappear in the long run if the cost of innovation does not fall with an increase in the number of products.

Substituting from equation (21) into (29) gives

$$x^N = \frac{a_N \alpha(\rho + g)}{n(1-\alpha)} \tag{30}$$

Let the unit labor requirement in imitation be $a_I$ and the cost function for imitation be given by

$$c_I = \frac{w^S a_I}{n_S} \tag{31}$$

where $n_S = n_I + n_M$ denotes the number of products produced in the South. The above cost function for imitation assumes that the cost of imitation declines with the number of goods produced in the South – i.e. both imitation and FDI generate knowledge spillovers for the South. The cost of imitation must decline over time in order to sustain imitation in the long run because as the number of products in the world economy expand, the flow profit of a successful imitator falls.

Free entry into imitation implies

$$v^S = \frac{w^S a_I}{n_S} \Leftrightarrow \frac{\pi^S}{\rho + g} = \frac{w^S a_I}{n_S} \tag{32}$$

Substituting from (24) into the above equation gives

$$x^S = \frac{a_I(\rho + g)}{n_S(\theta - 1)} \tag{33}$$

Using (11) gives

$$x^M = \frac{a_I(\rho + g)}{n_S(\theta - 1)\alpha^{-\varepsilon}} \tag{34}$$

Finally, from equations (29) and (32) we have

$$\frac{n}{n_S}\frac{a_I}{a_N}\frac{v^N}{v^S} = \frac{w^N}{w^S} \tag{35}$$

Substituting from (13) and (14) gives

$$\frac{n}{n_S}\frac{a_I}{a_N}\frac{\frac{(1-\alpha)w^N x^N}{\alpha}}{(\theta-1)w^S x^S} = \frac{w^N}{w^S} \Leftrightarrow \frac{n}{n_S}\frac{a_I}{a_N \alpha}\frac{(1-\alpha)x^N}{(\theta-1)x^S} = 1 \tag{36}$$

Using equations (27), (30), and (33) allows us to rewrite the above equation as

$$\frac{n_S}{n_N}\frac{n_N}{n}\frac{a_N}{a_I}\frac{\alpha^{1-\varepsilon}(\theta-1)}{(1-\alpha)}\left[\frac{\rho+g+\mu}{\rho+g}\right]^{\frac{\varepsilon}{\varepsilon-1}}=1 \tag{37}$$

Substituting from (19) and (20) gives us our **first equilibrium condition** in terms of three endogenous variables $g$, $\phi$, and $\mu$ and exogenous parameters of the model:

$$\frac{\frac{\phi}{g}\left[1+\frac{\mu}{g}\right]}{1+\frac{\phi}{g}\left[1+\frac{\mu}{g}\right]}\frac{a_N}{a_I}\frac{\alpha^{1-\varepsilon}(\theta-1)}{(1-\alpha)}\left[\frac{\rho+g+\mu}{\rho+g}\right]^{\frac{\varepsilon}{\varepsilon-1}}=1 \tag{38}$$

Intuitively, this condition follows from the assumption of free entry into imitation and innovation and it ensures that neither activity leads to excess profits for firms that are successful in these activities.

### 2.1.5 Resource Constraints

The other two equilibrium conditions are derived from the resource constraints in the two regions. In the North, labor is allocated to innovation and production:

$$\frac{a_N}{n}\dot{n}+n_N x^N=L^N \tag{39}$$

Substituting into the above resource constraint from equations (19), (20), and (30) yields the **second equilibrium condition**:

$$a_N g+\frac{g}{g+\phi\left[1+\frac{\mu}{g}\right]}\frac{a_N\alpha(\rho+g)}{(1-\alpha)}=L^N \tag{40}$$

Southern labor is allocated to imitation and production by multinationals and local firms:

$$\frac{a_I}{n_S}\dot{n}_I+\theta n_M x_M+n_I x^S=L^S \tag{41}$$

Substituting into the above resource constraint from equations (19), (20), (33), and (34), gives the **third equilibrium condition**:

$$a_I\frac{g\mu}{g+\mu}+\theta\frac{g}{(g+\mu)}\frac{a_I\rho}{(\theta-1)\alpha^{-\varepsilon}}+\frac{\mu}{g+\mu}\frac{a_I(\rho+g)}{(\theta-1)}=L^S \tag{42}$$

#### 2.1.6 Effects of Southern IPR reform

Equations (38), (40) and (42) define the steady state equilibrium of the model in terms of the three endogenous variables: the rate of innovation $g$, the rate of imitation $\mu$, and the rate of FDI $\phi$. An important objective of this paper is to understand how a strengthening of IPR protection in the South (as measured by an increase in the cost of imitation $a_I$) alters the distribution of production across the two regions as well as between Northern multinationals and Southern imitators.

Using the derivations in sections 2.1.1 and 2.1.2 it is straightforward to show that the total value of multinational sales relative to those of Southern imitators has the following simple expression:

$$\frac{n_M p^M x^M}{n_S p^S x^S} = \alpha^{1-\varepsilon} \frac{g}{\mu} \tag{43}$$

Thus, all else equal, factors that lower the Southern rate of imitation ($\mu$) or those that increase the Northern rate of innovation ($g$) will lead to an increase in sales of multinationals relative to those of Southern firms. Similarly, we have

$$\frac{n_M p^M x^M}{n_N p^N x^N} = \frac{\phi}{g} \left[\frac{\theta w^S}{w^N}\right]^{1-\varepsilon} = \frac{\phi}{g} \left[\frac{\rho + g}{\rho + g + \mu}\right] \tag{44}$$

In other words, all else equal, factors that increase the flow of FDI ($\phi$) or the Northern rate of innovation ($g$) as well as those that lower the Southern rate of imitation ($\mu$) will increase the value of multinational sales relative to those of Northern firms.

Assuming the rate of imitation $\mu$ is exogenously given, Lai (1998) has shown that *a strengthening of Southern IPR protection (i.e. a decline in* $\mu$*) increases Northern innovation (g) and the rate of production shifting to the South.*[9] The question, of course, is whether the above result holds when imitation is endogenous and the underlying exogenous variable is the cost of imitation $a_I$. To address this question, we first solve equation (38) for FDI flow $\phi$ in terms of the other two endogenous variables ($g$ and $\mu$) and then use the two resource constraints to derive a system of two equations in two unknowns which can be illustrated graphically. From equation (38) we have

$$\phi(\mu, g) = \frac{A(\mu, g)\,[1-\alpha]\,a_I g^2}{(\mu + g)\,[B(\alpha) a_N (\theta - 1) - A(\mu, g) a_I (1-\alpha)]} \tag{45}$$

[9] In the appendix, we show how our model can be reduced to that of Lai (1998).

where

$$A(\mu, g) = \left[\frac{\rho + g}{\rho + g + \mu}\right]^{\frac{1}{\alpha}} < \ 1 < B(\alpha) = \alpha^{\frac{\alpha}{\alpha - 1}} \tag{46}$$

It is worth noting that, holding constant the rates of imitation ($\mu$) and innovation ($g$), *the flow of FDI* $\phi(\mu, g)$ *to the South increases with the cost of imitation*:

$$\frac{\partial \phi(\mu, g)}{\partial a_I} = \frac{A(\mu, g)B(\alpha)(1 - \alpha)a_N g^2(\theta - 1)}{(\mu + g)\left[B(\alpha)a_N(\theta - 1) - A(\mu, g)a_I(1 - \alpha)\right]^2} > 0 \tag{47}$$

The intuition for this result comes from equation (37) which requires the rate of return on innovation and imitation to equal each other. Since the right hand side of this equation always equals 1, an increase in $a_I$ must be counterbalanced by an increase in the ratio of production ($\frac{n_S}{n}$) that occurs in the South for the cost of imitation to *not* increase relative to the cost of innovation (the cost of imitation in the South is assumed to be inversely proportional to $n_S$ – the number of goods produced in the South). Recall that

$$\frac{n_S}{n} = \frac{1}{\frac{1}{\frac{\phi}{g}\left[1 + \frac{\mu}{g}\right]} + 1} \tag{48}$$

i.e. holding $\mu$ and $g$ constant, an increase $a_I$ can increase the share of goods produced in the South ($\frac{n_S}{n}$) only if it implies a higher inflow of FDI ($\phi$) into the South.

Next, note from (41) that the Southern labor market constraint is *independent* of $\phi(\mu, g)$. Substituting for $\phi(\mu, g)$ into the Northern labor market constraint gives us two equations in two unknowns. Let $L^S(\mu, g) = L^S$ denote the Southern labor market constraint where $L^S(\mu, g)$ is the left hand side of equation (42) and it measures the total demand for labor in the South. We have

$$\frac{\partial L^S(\mu, g)}{\partial \mu} = \frac{a_I g\left[g\theta(B(\alpha) - 1) + \rho(B(\alpha) - \theta)\right]}{(\mu + g)^2 B(\alpha)(\theta - 1)} > 0 \tag{49}$$

where we have assumed that $B(\alpha) > \theta$. In other words, holding constant the rate of innovation $g$, factors that increase the rate of imitation $\mu$ must also increase the demand for Southern labor. A similar statement can be made about the rate of innovation:

$$\frac{\partial L^S(\mu, g)}{\partial g} = \frac{a_I\left[(B(\alpha)\mu(\mu\theta - \rho) + \theta(\rho\mu + 2g\mu + g^2)\right]}{(\mu + g)^2 B(\alpha)(\theta - 1)} > 0 \tag{50}$$

where we have assumed that $\mu\theta > \rho$.

Thus, the Southern labor market constraint is downward sloping in the $(g, \mu)$ space:

$$\left.\frac{d\mu}{dg}\right|_{L^S(\mu,g)=L^S} = -\frac{\frac{\partial L^S(\mu,g)}{\partial g}}{\frac{\partial L^S(\mu,g)}{\partial \mu}} < 0 \tag{51}$$

In other words, since the South has only a fixed amount of labor resources, an increase in the Southern rate of imitation $\mu$ implies that the rate of innovation $g$ that can be supported by the global economy must be lower.

Also,

$$\frac{\partial L^N(\mu, g)}{\partial \mu} = \frac{a_I(\rho + g)A(\mu, g)}{(\rho + \mu + g)B(\alpha)(\theta - 1)} > 0 \tag{52}$$

i.e. the higher the equilibrium rate of imitation $\mu$, higher the demand for Northern labor.

While the expression for $\frac{\partial L^N(\mu,g)}{\partial g}$ is rather complicated, it has a positive sign for most reasonable parameter values. Thus, the Northern labor market constraint is also downward sloping in the $(g, \mu)$ space. It is worth noting the role FDI plays in delivering this result. In the absence of FDI, in a variety expansion product cycle model such as Grossman and Helpman (1991b), the Northern market labor constraint is actually upward sloping in the $(g, \mu)$ space. In our model as well as in Lai (1998) and Helpman (1993), since imitation targets only multinationals, a higher rate of imitation implies that FDI is less attractive to Northern firms. If more Northern firms refrain from FDI due to an increase in imitation risk, fewer Northern resources are available for innovation thereby generating the property that the Northern labor market constraint is downward sloping.

One might question the plausibility of the notion that production workers could literally be easily redeployed as R&D workers, and this issue requires a slight digression. In keeping with the stream of theoretical research on which we build, we have constructed a model in which labor is the only factor of production. What we really seek to model in this one-factor context, however, is the essence of a more complex process by which multinationals are able to realize cost savings by shifting manufacturing abroad, then invest some of the resources saved in higher levels of R&D. In a fascinating industry case study, McKendrick et al. (2000) describe how U.S.-based hard disk drive manufacturers adopted precisely this strategy, using the resources saved through a shift of manufacturing to Asia to out-innovate their global rivals. Throughout the period under study, U.S.-based firms retained their leadership of global market share, even as manufacturing shifted almost entirely offshore while high-level R&D and other "headquarters services" functions remained concentrated in the U.S. The experience of the hard disk drive industry does not appear to be unique. At the aggregate level, the U.S. steadily lost manufacturing jobs throughout the 1990s, but productivity growth accelerated, patenting by U.S. firms increased sharply, and measures of R&D intensity rose. And while we observe relatively few assembly-line *workers* going directly into high-level R&D jobs, over time the U.S. *workforce* has employed a steadily smaller fraction in assembly-line jobs and a steadily higher fraction in jobs related to R&D, broadly defined. In a broader sense, the kind of resource reallocation we seek to model does appear to be taking place. We will return to these issues later in the paper.

For now, we invite the reader to consider how an increase in the cost of imitation impacts both of the labor market constraints, as they are represented in the paper. From equation (42) it is immediate that holding constant the rates of imitation and growth (i.e. $\mu$ and $g$), an increase in the labor requirement in imitation ($a_I$) increases labor demand in the South in all three activities (i.e. local imitation, production by Southern firms, and production by multinationals). This is equivalent to an inward shift in the Southern labor market constraint in the $(g, \mu)$ space.

From equation (40) we note that holding constant $g$ and $\mu$, an increase in $a_I$ effects the Northern labor market constraint via its effect on the rate of FDI $\phi$. Given that the flow of FDI $\phi$ increases in $a_I$ (see equation 47), it follows that labor demand in the North $L^N(\mu, g)$ (i.e. the left hand side of equation 40) decreases with an increase in $a_I$.

The effect of a strengthening of IPR protection in the South on equilibrium rates of imitation and innovation is shown in Figure 1. With an increase in the cost of imitation (i.e. $a_I$), the Southern labor market constraint shifts down while the Northern constraint shifts up. As a result, the rate of innovation $g$ increases while the rate of imitation $\mu$ decreases.[10]

[10] The following parameters were used to generate Figure 1: $L^S = 150$, $L^N = 200$, $a_N = 1$, $\rho = 1/100$, $\theta = 1.3$, and $\alpha = 1/2$. The cost of imitation $a_I$ parameter is increased from 0.5 to 0.55.

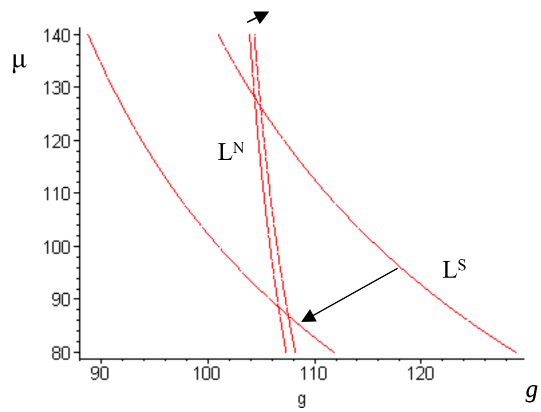


Figure 1: Effects of Southern IPR protection

To gain some insight into the degree to which a change in Southern IPR protection affects the allocation of production across the two regions as well as the relative wage, we conducted numerical simulations. Consistent with Figure 1, these simulations show that as IPR protection in the South is strengthened, the rate of imitation goes down whereas the rate of innovation and FDI both increase. As a result, the measure of goods produced by Northern multinationals ($n_M$) increases, the measure of imitated products ($n_I$) decreases, while the total measure ($n_S$) of Southern products increases. Table 1a below reports the results of one such typical simulation (assuming the following parameter values: $L^S = 150$, $L^N = 200$, $a_N = 1$, $\rho = 1/100$, $\theta = 1.3$, and $\alpha = 1/2$).[11]

Table 1a: Effects of increased IPR protection in the South

| $a_I$ | $\frac{n_S}{n}$ | $\frac{n_M}{n_S}$ | $\frac{w^N}{w^S}$ |
|---|---|---|---|
| 0.5 | 8% | 45% | 2.90 |
| 0.55 | 14% | 55% | 2.35 |
| 0.60 | 21% | 64% | 2.02 |
| 0.65 | 28% | 72% | 1.79 |
| 0.70 | 37% | 80% | 1.63 |

The intuition underlying the results shown in Table 1a (as well as those in Figure 1) is clear. A strengthening of Southern IPR protection makes imitation less attractive, thereby lowering the rate of imitation $\mu$. A lower risk of imitation makes FDI in the South more attractive to Northern firms

[11] Tables 1b and 1c in the appendix show that the results reported in Table 1 are robust to variations in $\theta$.

who respond by increasing the rate of FDI ($\phi$) which translates into a higher share of FDI in Southern production ($\frac{n_M}{n_S}$).[12] Also, note that as Southern IPR are strengthened, the South ends up producing a greater percentage of the world's basket of goods ($\frac{n_S}{n}$). This happens even though the share of imitated goods as a percentage of total Southern production ($\frac{n_I}{n_S}$) shrinks because the increase in FDI offsets the decline in imitation.

Whereas Helpman (1993) found that stronger IPR retards Southern industrial development, we find that stronger IPR enhances it, at least in theory. In Table 1a, a 40% increase in IPR causes the South's share of total manufacturing to more than quadruple. Due to the FDI response, the pace at which the basket of goods produced in the South grows is also more rapid than in a weak IPR equilibrium. In addition, stronger IPR raises the relative wage of Southern workers.[13] In Table 1a, a 40% increase in IPR shrinks the North-South wage gap by nearly 44%. By shifting production in favor of multinationals, it lowers prices of goods previously produced in the North, and enhances the efficiency of global production. Finally, by freeing up additional resources in the North, stronger IPR in the South increases the rate of Northern innovation, benefitting both regions. Over time, more goods are available to consumers worldwide, and they arrive at a faster rate. On the other hand, these benefits do come at a cost. By increasing production by multinationals while reducing that by Southern imitators, stronger IPR in the South can lead to higher prices on some goods for consumers in both regions. The precise magnitude of this countervailing price effect is difficult to determine in the context of our current model. For this reason, we stop short of a full-fledged welfare analysis, leaving this for future work. Instead, we turn our focus from theory to empirical analysis.

# 3 Empirical Analysis of IPR Reform

The theory developed in Section 2 shows how stronger IPR can enhance the industrial development of developing countries, though the channel of multinational production shifting. Does this result obtain in practice? In

[12]A slight subtle point to note here is that the decline in Northern relative wage counteracts the lower risk of imitation in the South – lower relative wage in the North means there is weaker incentive to produce in the South whereas a lower imitation risk implies that there is a stronger incentive to do so. The effects of Southern IPR protection captured in Figure 1 and Tables 1a-1c apply so long as the relative wage effect is dominated by the imitation risk effect (as it indeed seems to be for reasonable parameter values).

[13]In contrast to Helpman (1993), in our model, FDI does not equalize wages in the two regions – see equation (27).

assessing this question, we can obtain from our model several useful predictions that can be taken directly to data. First, the model indicates that multinational firms respond to reforms by increasing production in reforming countries. Second, growth in production by multinationals and local firms that are not engaging in imitation exceeds the decline in any imitative actiivty that was occuring prior to reform. Finally, the pace at which multinationals introduce the production of new products to their affiliates accelerates following reform. This section describes and reports results of tests of each of these three predictions.

In the tests that follow, we analyze the effects of well-documented discrete changes in patent regimes over the 1980s and 1990s in sixteen countries. We use the regime changes of Branstetter, Fisman, and Foley (forthcoming), which assembles a comprehensive list of substantive IPR reforms based on a number of primary and secondary sources. Limiting the set of regime changes to those with sufficient multinational activity yields a final sample of 16 reforms, which are listed in Table 2.[14] The approach of analyzing responsiveness to discrete and well-defined changes has a number of advantages. It allows for the use of fixed effects that control for features of the business environment in a country that are correlated with the strength of IPR. Furthermore, since tests capture the short-term reaction to strengthening IPR, it is not necessary to create a measure of the level of IPR strength that accurately and consistently measures this variable over time and across countries.[15]

The reader will note that we include patent reforms in Japan in our sample. If one were to compare Japanese per-capita income to that of the U.S. at market exchange rates, it would be hard to characterize Japan as a "developing country." However, many students of the Japanese economy have repeatedly pointed to the existence of a dual economy in Japan, with some Japanese industries achieving extremely high levels of productivity relative to the U.S. and other industries lagging far behind the U.S. productivity

[14] A detailed discussion of the particulars of these sixteen reform episodes is provided by Branstetter, Fisman, and Foley (2005) and their accompanying Data Appendix. As discussed at length in that earlier work, multinational managers have questioned the effectiveness of enforcement of the patent reforms instituted in Argentina and China. We therefore take steps to ensure that our results are robust to the removal of these countries from the sample.

[15] Our approach clearly limits our focus to countries in which there has been a reasonable amount of U.S. FDI activity. While the 16 countries in our sample are quite heterogeneous in terms of their income, location, and industrial development at the time of reform, we recognize the need to exercise caution in extrapolating these results to countries outside the sample.

frontier.[16] Given the substantial relative productivity lags that existed in some sectors, particularly at the beginning of our sample, we incorporate data from Japan in the empirical analyses described below. However, we note that our results are robust to the removal of Japan from the sample.

A. Multinational Firm Responses

A.1.Empirical Specifcation

In examining the model's prediction that stronger IPR induces an expansion of multinational activity, we take a difference-in-differences approach. Individual affiliates are followed through time, and the basic specification tests how the scale of MNE activity changes at around the time of reform. The highly disaggregated nature of our data allow us to control for country, parent firm, and affiliate characteristics that might impact the behavioral variables of interest, and hence obtain estimates that are conceptually close to the measurement of the marginal impact of an IPR regime shift on these variables. The basic specification takes the form:

$$S_{ilt} = \alpha_0 + \alpha_{il} + \alpha_t + \beta_0 y_{jt} + \beta_1 P_{it} + \beta_2 H_{jt} + \beta_3 R_{jt} + \beta_4 R_{jt} * Pat_{il} + \varepsilon_{it} \quad (53)$$

where $l$ indexes the individual affiliate, $i$ the affiliate's parent firm, $j$ the affiliate's host country, and $t$ the year. Several measures of the scale of multinational activity serve as dependent variables. In the theory section, this concept is unambiguously defined, and it corresponds to the number of distinct products for which production has shifted to the South. The data on multinational activity are at the affiliate level, but they do not cover the sales of individual products. Hence, our measures of the scale of multinational activity likely reflect both an expansion of the range of products produced and an expansion of the scale of production for individual products. In addition, changes in measures of affiliate activity such as sales could reflect changes in prices as well as changes in output volume. In the context of a strengthening of the patent system, this could lead to inference problems. Stronger patent laws confer a higher degree of monopoly power on the incumbent patent holder, possibly leading to higher prices for patent-protected goods. Unfortunately, affiliate-product specific price indices are not available. Given this inexact correspondence between theory and data, we measure the expansion of multinational activity in reforming countries along three dimensions: affiliate sales, capital stock, and employment. An

[16] See McKinsey Global Institute (2000) and Porter, Takeuchi, and Sakakibara (2000) for recent examinations of this problem, which has existed for many decades.

increase in sales alone in the wake of local patent reform could be explained by an increase in prices. However, an expansion in all three indicators of affiliate scale is more likely to reflect a real expansion in the level of multinational activity.

The key variable of interest is $R_{jt}$, the post reform dummy variable, as well as $R_{jt}$ interacted with a variable, $Pat_{il}$, that reflects a firm's patent intensity. $R_{jt}$ is equal to one in the year of and years following patent reform in country $j$. $Pat_{il}$ is generated as follows: Those affiliates of parents that, over the four years prior to a particular reform, average at least as many U.S. patent applications as the parent of the median affiliate in the reforming country over the same period are assigned a high patent use dummy, $Pat_{il}$, equal to one. For other affiliates that have parents that can be matched to the NBER patent database, $Pat_{il}$ equals zero. As in Branstetter, Fisman, and Foley (2005), we assert that the expansion of the scale of multinational activity in response to stronger IPR should be largest for firms that value patent protection the most, so that $\beta_4 > 0$.

The specification also includes a number of controls: Time-invariant fixed effects for the affiliate ($\alpha_{il}$), year fixed effects for the entire sample ($\alpha_t$), and country-specific time trends; $P_{it}$ and $H_{jt}$ are vectors of time-varying parent and host country characteristics respectively. We control for the total sales of the parent system as well as the level of parent firm R&D spending. Host country characteristics include per capita GDP, measures of trade and FDI openness, corporate tax rates relative to the U.S. We do not view this basic specification as a structural production function (or investment equation) in any sense, and we do not impute structural interpretations to any of the regression parameters generated by such a specification. Instead, our sole purpose is to investigate the ceteris paribus impact of a strengthening of patent rights on the scale of the firm's operations. If we find that sales, labor input, and capital input all expand significantly in the wake of patent reform, that would be consistent with, if not necessarily proof of, an expansion of multinational activity along the dimensions stressed in our theoretical model.

Two potential concerns about the basic specification are worth noting. First, this approach assumes that the precise timing of the regime change is exogenous to the activities of the individual firms.[17] Second, as we have already noted, the measures of multinational scale could reflect an expansion

[17]Branstetter, Fisman, and Foley (forthcoming) provide detailed historical and econometric evidence suggesting that the exact timing of patent reform is likely to be plausibly exogenous to the activities of our sample firms.

in the scale of production of previously produced products as well as the introduction of new products. One would like to have assurance that expansion along the latter dimension – the dimension stressed by our theoretical framework – is more than trivial. While affiliate data do not directly identify new product introductions, they do track transfers of technology from parent to affiliate and such transfers are arguably highly correlated with the introduction of new products.[18] We use specifications similar to those presented in Branstetter, Fisman, and Foley (forthcoming) to test whether technology transfers increase around the time of reform. These specifications take the same form as the specification in equation (53), and use a dependent variable that measures the volume of intrafirm royalty payments for intangible assets – our proxy for technology transfer. If the increase in the value of technology flows from parent firms to affiliates is actually from improved IPR protection (and not, for example, from correlated reforms), the effect should be largest for firms that value patent protection the most, so that our variable of primary interest is once again the interaction of the reform dummy and patent intensity dummy.

As pointed out in Branstetter, Fisman, and Foley (forthcoming), changes in the value of licensing payments could reflect changes in the volume of technology transferred or merely changes in the price charged for that technology. Analyzing changes in the R&D expenditures of affiliates is helpful in distinguishing between these two possibilities. There is a considerable body of work that details the relationship between affiliate and parent-firm R&D. While U.S.-based multinationals undertake basic and applied research abroad, the R&D conducted by affiliates in developing countries, which account for most of the countries in our sample, is focused on the modification of parent firm technology for local markets.[19] The literature review presented in Kuemmerle (1999) makes the point that a number of studies suggest that the co-location of R&D with foreign manufacturing facilitates the "transfer of knowledge and prototypes from the firm's home location to actual manufacturing." Viewed in this light, affiliate R&D and technology transfers from the parent should be considered complements, and given this complementary relationship, IPR reform should also generate an increase in

[18] The landmark study of Teece (1976) showed that royalties are charged with technology is transferred, although these costs are often only part of the total resource cost of the transfer. Extensive discussions with technology transfer consultants confirmed that U.S. firms continue to record an increase in licensing payments when there is a substantial deployment of new technology to their affiliates.

[19] Teece's (1976) study also pointed to the need to modify imported technology to meet local conditions.

R&D spending.

A.2. Data

Data on U.S. multinational firms comes from the U.S. Bureau of Economic Analysis (BEA) annual Survey of U.S. Direct Investment Abroad and the quarterly Balance of Payments Survey. The survey forms concerning MNE activity capture extensive information on measures of parent and affiliate operating activity like levels of sales, employment, capital, and R&D expenditures. MNEs must also report the value of royalties paid by affiliates to parents for the sale or use of intangible property. American tax law requires that foreign affiliates make these payments. The reported figures on the value of intangible property transferred include an amalgam of technology licensing fees, franchise fees, fees for the use of trademarks, etc. However, the aggregate data indicate that intangible property transfers are overwhelmingly dominated by licensing of industrial products and processes.

The top panel of Table 3 provides descriptive statistics for the data used in our analysis of U.S. multinational firms. A number of other databases are used to augment the information on U.S. firms in the BEA data. In order to obtain information on parent firm R&D expenditures in years in which this item was not captured in BEA surveys, the BEA data on publicly traded parents is linked to COMPUSTAT using employee identification numbers. Parent firm data is also linked to data on patenting activity captured in the NBER patent citation database. This comprehensive database covers all patents granted by the U.S. Patent and Trademark Office (U.S. PTO) throughout the 1982-1999 sample period. These data provide a rich picture of the evolving technological trajectories of parent firms and are used to test if patent reforms have larger effects for firms that make more extensive use of the U.S. patent system prior to the reforms.

A.3 Results

Table 4 presents the results of specifications based on equation (53) that test if affiliates increase the scale of their operations at the time of reform. The dependent variable in column 1 is the log of the level of affiliate sales. The 0.091 coefficient on the IPR Reform dummy and the 0.108 coefficient on the IPR Reform dummy interacted with the Patent Intensity dummy indicate that affiliates of U.S. MNEs increase sales at the time of reform and that such increases are more pronounced among affiliates of firms that made extensive use of the U.S. patent system prior to reforms. Since the dependent variable is measured in logs, these coefficients have a semi-elasticity interpretation, implying that affiliates of patent intensive firms increase sales by 19.9% following reforms.

The second column presents results of the same specification, with the log of affiliate employment used in place of the log of sales as a dependent variable. Although the coefficient on the IPR Reform dummy is insignificant, the coefficient on this variable interacted with the Patent Intensity dummy is positive and significant. This result implies that affiliates of firms that make extensive use of the U.S. patent system prior to reform increase their employment by 4.8% more than other affiliates following reform. The third column presents estimates of the impact of reform on affiliate capital stocks, measured as the log of net plant, property, and equipment.[20] For this dependent variable, the coefficient on the IPR Reform Dummy is positive and insignificant while the coefficient on the interaction term is positive and significant. It indicates that affiliates of patent intensive firms increase their capital stocks by 10.9% following reform.

While the results of the first three columns all imply an expansion of the scale of multinational activity in the wake of patent reform, they do not necessarily imply an expansion in the scope of multinational activity – that is, an acceleration in the rate at which the production of new goods is transferred to the South. As we have already noted, our affiliate level data are not sufficiently disaggregated for us to identify the production of new goods. However, the production of new goods is likely to require new technology from the parent firm, and the data do include a proxy for the transfer of technology from parents to affiliates, namely royalties paid by affiliates to parents for the sale or use of intangible assets. This variable is the dependent variable used in the specification presented in column 4 of Table 4.

The results of this specification, which parallels those reported in Branstetter, Fisman, and Foley (forthcoming), indicate that there is a pronounced increase in technology transfer following reforms among affiliates of firms that make extensive use of the U.S. patent system. The coefficient on the patent reform dummy is small and statistically insignificant. The coefficient on the interaction term, however, is positive, highly significant, and large in magnitude. Taken together, the results imply a marginal increase in the level of annual licensing payments of about 30% for patent intensive firms. To the extent that technology transfer is proportional to licensing payments, such a large increase, cumulated over several years, would im-

[20] The measures of affiliate capital stock are taken directly from the response of affiliates to BEA surveys. Because of the limited availability of pre-sample investment data, it would be difficult for us to construct our own capital stock measures through the use of perpetual inventory techniques.

ply a substantial increase in the technological intensity of affiliate activity. This specification is estimated using affiliate sales as an additional control. Alternative specifications using the licensing payments to sales ratio as an alternative dependent variable generated qualitatively similar results.

Column 5 shows the results of a specification using affiliate R&D spending as the dependent variable. Most R&D spending by U.S.-based multinational firms is concentrated in the U.S. However, some foreign affiliates of U.S. firms do spend on R&D. As noted by Branstetter, Fisman, and Foley (forthcoming), the vast majority of this R&D spending is designed to modify the parent firm's technology to local circumstances and conditions. It can thus be seen as a complement to technology imports from the parent. If the post-reform increase in technology licensing payments identified in column 4 truly represents the deployment of new technology (rather than simply an increase in the price of technology), then that increase to be mirrored by an increase in affiliate R&D spending. Column 5 shows evidence that this is the case: for patent intensive parents, there is a significant post reform increase in affiliate R&D. This specification is estimated using affiliate sales as an additional control. Alternative specifications using the R&D to sales ratio as an alternative dependent variable generated qualitatively similar results.

We note elsewhere in the paper that, while IPR-strengthening legislation was enacted in Argentina and China in the 1990s, multinational managers have repeatedly called into question the effectiveness of enforcement of reform in these two countries. We therefore re-ran each of the specifications shown in Table 4 with a restricted sample that dropped Argentina and China from the data base. We obtained results qualitatively similar to those shown here.[21]

B. Industry-Level Output Responses

While the preceding results have the advantage of showing the effects of IPR reform on U.S. multinational activity using highly disaggregated data, these analysis do not indicate the consequences of reform for multinationals from other countries or for local firms. For this broader set of producers, our model implies that overall levels of economic activity should increase, as Southern industrial development is enhanced and the share of global manufacturing in the South rises. We should observe large enough growth in activity by MNEs and local firms that are not engaged in imitation to offset any decline in activity among local imitators. While we cannot examine these predictions with firm-level data, we may analyze broad economic changes using industry-wide measures of production in reforming countries.

[21] These results are available from the authors upon request.

B.1 Empirical Approach and Data

We examine the impact of IPR reform on industrial output and value added using a specification similar to that employed in the previous section:

$$VA_{ijt} = \alpha_0 + \alpha_{ij} + \alpha_t + \beta_0 y_{jt} + \beta_1 H_{jt} + \beta_2 R_{jt} + \beta_3 R_{jt} * Tech_i + \varepsilon_{it} \quad (54)$$

where $VA$ measures value added in industry $i$ in country $j$ in year $t$. The controls in the specification include an overall constant term, country-industry pair fixed effects, time dummy variables, host country-specific linear time trends, and a vector of time-varying characteristics of country $j$, including the log of per capita income, the tax rate, the real exchange rate, and the measures of FDI and trade openness used in earlier specifications. The primary variable of interest is $R_{jt}$ , the post reform dummy, and the interaction terms constructed with it. In some specifications, we allow the impact of IPR reform to vary in industries in which technological innovation is likely to be particularly important to the strategies of firms, both multinational and domestic. We do this by first constructing a dummy variable that identifies "innovation intensive" industries: electrical machinery, industrial chemicals, other chemicals, professional and scientific equipment, and transportation equipment. This dummy variable is then interacted with our country-specific reform dummy variable. We can also examine the cross-industry distribution of U.S. FDI in countries where intellectual property is well protected throughout our sample, identify these industries with a dummy variable equal to 1, and interact this with the reform dummy, to see if the impact of reform is particularly strong in these sectors.[22]

Data are drawn from the United Nations Industrial Development Organization (UNIDO) database, which provides measures of value added at the ISIC 3-digit level in a common format for a large number of member states. While data is not available on all ISIC 3-digit industries for all reforming countries in all years, there is reasonably complete coverage for most countries in most years. Data incorporate the activity of multinational affiliates as well as domestic firms. Descriptive statistics for the data used in our industry level value added regressions are provided in the middle panel of Table 3.

B.2 Results

[22] We use the Ginarte and Park (1997) index to identify countries that had a high G-P index of IPR strength in 1980, which precedes our sample. We then identify the BEA sectors in which FDI is particularly concentrated, and use a concordance of BEA-ISIC industries to identify the corresponding ISIC industries.

Table 5 reports results obtained from regressions of equation (54) on industry level value added measures obtained from the UNIDO 3-digit industry-level database. The positive coefficient on the reform dummy suggests that growth in value added relative accelerates after patent reform, but this effect is not statistically significant at conventional levels. Column two reports the results of a specification of (54) that includes the interaction of reform and innovative intensity of the industry. The interaction term is positive and statistically signficant, implying that the output expansion indicated in the first columns is concentrated in technologically dynamic industries, where we would expect it to be. Concerns that IPR reform might induce a collapse of indigenous industrial activity so great as to undermine the positive effect of multinational expansion are not borne out in the data. Instead, the point estimate implies an expansion of industry level value added, relative to the underlying trend, of more than 11%. Additional reassurance is provided by the results in column 3, in which reform is interacted with a dummy variable that identifies the industries in which U.S. FDI is concentrated worldwide. Again, the interaction term is positive and statistically significant.

As we have noted elsewhere, multinational managers have raised questions about the effectiveness of enforcement of IPR reform in Argentina and China. Given the particularly robust industrial expansion in China in the 1990s, it is important to ensure that our results are not driven by that country. Columns 3-6 present results obtained when we re-run the regressions in columns 1-3 on a sample that excludes both Argentina and China. As the reader can see, this does not qualitatively affect our results. The overall impact of reform on all industries remains statistically indistinguishable from zero, but the interaction terms remain positive and statistically significant, suggesting a positive impact of IPR reform in those sectors where it is most likely to matter for foreign and indigenous firms. Overall these results strengthen the view that the expansion of multinational activity documented in Table 4 is not undermined by a collapse of indigenous firm activity.

C. Initial Export Episodes

Interpreted strictly, our model's predictions focus on the introduction of production of new goods following reform. While the measures of affiliate activity analyzed in Section 3.A *reflect* the introduction of new goods to foreign affiliates, they are not sufficiently disaggregated to permit us to track affiliate activity at the individual product level. Because neither the BEA data nor the UNIDO data allow us to get down to the product level, we use an approach inspired by Feenstra and Rose (2000) that may allow us to capture more directly the extent of new production initiation in reforming countries.

This approach requires the use of disaggregated U.S. import statistics to obtain counts of initial export episodes–the number of 10-digit commodities for which recorded U.S. imports from a given country exceed zero for the first time. This approach is imperfect in that domestic production may precede exports by several years, but in the Helpman framework and its descendents, a strengthening of IPR in the South impacts the global economy through Southern exports of new (to the South) goods. Furthermore, since the U.S. is the world's single biggest market for many commodities, looking at the date at which a particular country starts exporting a particular good to the U.S. may be a reasonable indicator of production shifting for that good. The specific question we will examine is whether the rate of production shifting is more rapid after patent reform. Our model suggests this shift should take place; in this sense, the model predicts an acceleration of the pace of industrial development in reforming countries. This prediction runs counter to oft-voiced concerns in developing countries that premature imposition of strong intellectual property rights will retard the rate of industrial development in reforming countries.

The notion of "production shifting" implies the initiation of production in developing countries and the cessation of production in developed countries. Unfortunately, our multinational production data are not sufficiently disaggregated for us to identify the cessation of production of a particular good by our multinational parent firms, and the aggregation problems are even more severe in the publicly available U.S. industrial output statistics. Because of these data constraints, we are only able to examine one side of the production shifting coin. That being said, there is evidence that the expected cessation of production of certain goods in the U.S. is taking place. A recent study by Bernard, Redding, and Schott (2005) uses confidential plant-level data from the LRD to show that cessation of production of certain goods is occurring at a fairly rapid rate within U.S.-based manufacturing plants. These authors document a shift to the production of more capital- and skill-intensive goods (that is, more sophisticated goods) on the part of surviving plants, consistent with the evolving comparative advantage of U.S. manufacturers. Plants that do not shift their product mix in this way are less likely to survive. These patterns are broadly consistent with the view of "production shifting" presented in Section 2.

C.1 Empirical Approach and Data

The dependent variable in this analysis is a count variable that measures, for a given country in a given year, the number of 10-digit commodities that were exported to the U.S. for the first time. One could think of this as a proxy for the arrival rate of new production. This count is regressed on country-year variables that control for a country's changing export capabilities using the following specification:

$$P_{jt} = \alpha_0 + \alpha_j + \alpha_t + \beta_0 H_{jt} + \beta_1 R_{jt} + \varepsilon_{it} \qquad (55)$$

where $P$ measures the number of 10-digit initial export episodes coming from country $j$ in year $t$. This is regressed on an overall constant term, country dummy variables, time dummy variables, a vector of time-varying characteristics of country $j$, and the reform dummy variable. The country characteristics are the same as those used in the previous table. Unlike the industrial output data, these data do not exhibit any clear upward trend over time – this is unsurprising, given that we are looking at new export categories in a given year.

A positive coefficient on the reform dummy would indicate that reforms spur the rate at which new products are produced in reforming countries, suggesting an acceleration in the pace of industrial development in reforming countries. Following the logic traced out by Helpman (1993) and Lai (1998), this would imply that additional resources get freed up in developed countries with strong IPR allowing an acceleration in the rate of Northern innovation and, in turn, an increase in the range of goods available to consumers in all countries.

The data used to perform this analysis are drawn from the U.S. trade database created by Feenstra, Romalis, and Schott (2001). Annual data on U.S. imports from nearly all the world's countries are available at the 10-digit level of disaggregation, which is very close to the individual product level. One major issue with these data is that the 10-digit commodity classification system was extensively revised in 1989. As a consequence, data before and after the revision are not really comparable at the most disaggregated level. The data do come with a correspondence that allows one to link the 1970s-era classification to the later harmonized system, but this mapping is neither unique nor exact. Most attempts to link the pre- and post-revision data are done at a much higher level of aggregation – but going up to the 5-digit or 4-digit level would extinguish many of the new product introductions that we are trying to measure. We therefore focus on results obtained using only those post-1988 years for which our data are measured consistently.[23]

[23] We note that results obtained using data from 1982-1999 are qualitatively similar to those reported here. Because of the significant reclassification of data in 1989, however, the dependent variable is not being measured consistently in this broader sample, calling into question the results.

Descriptive statistics for the data employed in our analysis are provided in the bottom panel of Table 3.

C.2. Results

Table 6 provides results from regressions that take the form of equation (55). The dependent variable measures the count of initial export episodes at the 10-digit level. Given the count nature of the dependent variable, it is appropriate to use an econometric specification designed for count data. Column 1 provides results of the Poisson fixed effects regression model derived by Hausman, Hall, and Griliches (1984). In this specification, we use data on initial export episodes in all product categories and in all reforming countries. The 0.224 coefficient on the IPR Reform dummy is positive and significant, and implies an increase in the arrival rate of new goods on the order of 22%.

In column 2, we continue to employ a Poisson fixed effects model, but we only measure initial export episodes in product classes that can be associated with R&D-intensive industries. If the post-reform acceleration in product-shifting is truly driven, at least in part, by the reaction of multinationals to stronger IPR, then we would expect to see effects at least as large as those obtained from the whole sample if we restricted our view to "technology-intensive" goods. When we do so, we obtain an effect that is positive and statistically significant. The point estimate is slightly larger than that in column 1 in terms of magnitude, although the confidence intervals overlap.

These basic patterns are confirmed in other specifications. Recalling the doubts that have been expressed about patent reform in Argentina and China, we drop these countries from our sample. Again, the regression results suggest a positive, statistically significant impact of patent reform on production shifting. The significant coefficient in column 3 implies an acceleration of about 23% when we examine initial export episodes in all product categories. When we restrict our set of initial export episodes to those in technology-intensive industries, the point estimate suggests a statistically significant acceleration of nearly 30%.

Following Hausman, Hall, and Griliches (1984), we also employ their fixed effects negative binomial model as an alternative specification. In column 5, we use the count of initial export episodes in all product categories and all reforming countries. Our results imply a statistically significant increase in the arrival rate of about 18%. When we restrict our focus to counts of initial export episodes in high tech products, we obtain a coefficient that is significant at the 10% level, but not the 5% level. In this case, the point estimate is also slightly lower than that obtained from a count of initial export episodes in all product categories. However, when we drop Argentina and China from the sample, as in columns 7 and 8, the earlier pattern reappears. The impact of reform is consistently statistically significant at the 5% level, and the point estimate is higher for counts in only high-tech product categories. These results provide further evidence for the view that IPR reform actually accelerates Southern industrial development.

# 4 Conclusion

In the 1990s, the international economic policy agenda shifted from its traditional postwar focus on the reduction of tariff and non-tariff barriers to international trade to the embrace of stronger intellectual property rights around the world. This shift occurred largely at the behest of the advanced industrial nations, particularly the United States. It has been – and remains – deeply controversial, even today, ten years after the incorporation of the TRIPs agreement into the WTO charter. Sharp disagreements persist over the impact of this shift on developing nations. Unfortunately, the economics literature to date has shed relatively little light on this debate, despite the best efforts of many talented researchers.

Policymakers and industrialists in developing countries have often expressed concern that the negative impact of adoption of stronger IPR would extend far beyond an increase in prices for patent-protected goods. These critics of stronger IPR in developing countries have repeatedly suggested that premature adoption of stronger IPR would retard the pace of Southern industrial development, limit the role developing countries play in global manufacturing, and thereby delay or even reverse wage convergence with the North. The theoretical literature initiated by Helpman (1993) has provided strong intellectual underpinnings for these concerns, elegantly capturing the conditions under which stronger IPR can have these negative effects. This theoretical literature has also shown how the positive effect of stronger IPR on incentives to innovate could be undermined (and global welfare reduced) in the long run by Northern resource constraints, as production gets reallocated from the inexpensive South to the high-cost North. On the other hand, subsequent models have also shown how stronger IPR could lead to faster industrial development in the South and faster innovation in the North. The ultimate impact of stronger IPR in the South on the global economy hinges on the manner and the extent of the multinational response to them. If multinationals respond to stronger IPR by shifting production to their Southern affiliates, this could more than compensate for a decline in Southern imitation. In general, the literature based on Helpman's model has shown that, where stronger IPR in the South leads to an *acceleration* of production-shifting, it tends to lead to faster industrial development in the South, a greater degree of North-South wage convergence, and higher rates of innovation in the North. The theoretical model we present in this paper shows that these results hold under a fair degree of endogeneity.

These theoretical results opens up an opportunity for empirical work to clarify the nature of the impact of stronger IPR in the South on the extent and pace of industrial development in the South. We present in this paper a mix of evidence drawn from U.S. affiliate-level data and U.S. import data. All of the evidence points in the direction of stronger IPR in the South *accelerating* the rate at which multinational production of goods gets transferred to Southern countries. We find that discrete IPR regime changes in sixteen countries leads to an expansion of multinational activity in those countries along multiple dimensions. Affiliate sales, employment, and capital stock all increase, and the increase is disproportionately concentrated in the affiliates of patent-intensive parents, for whom patents and other kinds of intellectual property are likely to be an especially important component of corporate strategy. We also find that parent firms provide more technology to their affiliates, and affiliates increase their R&D spending in the wake of patent reform. As we argue in the paper, this is consistent with parent firms deploying new technology to their affiliates so that these affiliates can begin the manufacture of new, more sophisticated goods.

In principle, the increase in production-shifting through multinational firms could crowd out imitative activity by indigenous Southern producers, with ambiguous effects on the total net amount of production shifting. To address this concern, we provide evidence from industry-level value-added data and from highly disaggregated U.S. trade data strongly suggesting that this does not occur. Instead, data measuring the "initial export episodes" of tradable goods from our IPR reforming countries suggests that the increase in production-shifting through multinationals more than compensates for any deceleration in production-shifting through imitation. Analyses of changes in industrial activity after reform also indicate that aggregate value added at the ISIC 3-digit industry level expands in reforming countries, especially in the technology-intensive industries likely to be disproportionately affected by reform. Stronger IPR in the South appears to lead to an acceleration of production-shifting, enhancing Southern industrial development. In the longer run, the logic of the models we build upon suggests that this will free up Northern resources for investment in innovative activity.

In this paper, we do not attempt to estimate the precise magnitude or exact timing of these longer-run general equilibrium impacts. However, other researchers have noted a robust expansion of U.S. innovative activity in the 1990s, even as manufacturing jobs have continued to move offshore. Relative to inventors based in other countries, U.S.-based inventors appear to have increased their generation of new ideas.[24] Along with this surge in innovative outcomes has come an acceleration in total factor productivity growth – an acceleration which has persisted in recent years.[25] These are complex phenomena with multiple causes, and one would not want to make too much of the broad coincidence in time between the domestic downsizing and offshoring of American manufacturing and the acceleration of American innovative activity. But these recent developments are certainly consistent with the kind of general equilibrium resource reallocation stressed in Grossman-Helpman style product cycle models. Exploring the potential link between production shifting and the apparent acceleration of innovation in U.S. industry in a more systematic way at the industry and firm level is a focus of ongoing research.

# 5 Appendix

In this appendix, we discuss the relationship of our model to Lai (1998) and also show that the numerical results reported in Table 1a are robust to variations in $\theta$.

## 5.1 Relationship of model to Lai (1998):

Our model differs from Lai's in two main ways. First, and most importantly, imitation is endogenous in our model whereas it is exogenous in his model. Second, unlike us, Lai (1998) interprets $\sigma$ where

$$\sigma = \frac{\dot{n_S}}{n_N}$$

as the rate of multinationalization. However, $\sigma$ measures an expansion in the Southern production base that results both from multinationals as well as local imitation. Strictly speaking, only products made by Northern multinationals ought to count as those that have been multinationalized. The other products made in the South are those that have been imitated by

[24]See Kortum and Lerner (1999) for a discussion of evidence based on patent data.
[25]See Gordon (2003) and the studies cited therein.

Southern firms and whose production can longer be controlled by Northern firms. In our terminology, only those goods that are produced by Northern multinationals are viewed as being multinationalized and the rate of FDI is measured by $\phi \equiv \frac{\dot{n}_M}{n_N}$.

Setting $\theta = 1$ and assuming $\mu$ is exogenous simplifies our model down to Lai's. In that case, the two endogenous variables (i.e. $g$ and $\phi$) must satisfy the following two equations:

$$\left[\frac{\sigma}{g}\left(\frac{\mu + \mu\alpha^{-\varepsilon}}{\mu + \mu}\right)\left(\frac{L_N - ag}{L_S}\right)\right]^{\alpha} = \frac{\rho}{\rho + \mu}$$

and

$$\left(\frac{1-\alpha}{\alpha}\right)(L_N - ag)(\frac{\sigma}{g} + 1) = a\rho$$

where

$$\sigma = \phi(1 + \frac{\mu}{g})$$

The following result is proved in Lai (1998): *a strengthening of Southern IPR protection (i.e. a decrease in the rate of imitation $\mu$) increases the Northern rate of innovation $g$.* The proof proceeds in a straightforward fashion: the implicit function theorem is applied to the above equation to determine the sign of $\frac{dg}{d\mu}$.

### 5.2 Effects of variation in $\theta$

Tables 1b and 1c below show that the effects of Southern IPR protection on FDI and the international allocation of production reported in Table 1a are robust to variations in $\theta$ (i.e. the parameter that captures the cost disadvantage of multinationals relative to local Southern firms). This parameter is critical because it directly affects incentives for both FDI and Southern imitation. All else equal, an increase in $\theta$ weakens the incentives for FDI whereas it strengthens the incentives for imitation. In Table 1b $\theta = 1.25$ whereas in Table 1c, $\theta = 1.35$.[26] As can be seen from Tables 1a-1c, the bigger is $\theta$, the smaller the extent of FDI and larger the Northern relative wage. The intuition is that when $\theta$ is high, imitation is highly attractive to Southern firms and this acts as a deterrent for FDI which in turn raises demand for Northern labor (while reducing it for Southern labor). This change in relative demand for labor translates into a higher relative wage in the North.

[26] Recall that in Table 1a, $\theta = 1.3$.

Table 1b: Effects of increased IPR protection in the South (for $\theta = 1.25$)

| $a_I$ | $\frac{n_S}{n}$ | $\frac{n_M}{n_S}$ | $\frac{w^N}{w^S}$ |
|---|---|---|---|
| 0.5 | 18% | 61% | 2.05 |
| 0.55 | 27% | 71% | 1.77 |
| 0.60 | 38% | 79% | 1.58 |
| 0.65 | 49% | 87% | 1.44 |
| 0.70 | 62% | 94% | 1.33 |

Table 1c: Effects of increased IPR protection in the South (for $\theta = 1.35$)

| $a_I$ | $\frac{n_S}{n}$ | $\frac{n_M}{n_S}$ | $\frac{w^N}{w^S}$ |
|---|---|---|---|
| 0.5 | 4% | 32% | 3.97 |
| 0.55 | 7% | 42% | 2.94 |
| 0.60 | 12% | 52% | 2.41 |
| 0.65 | 17% | 61% | 2.07 |
| 0.70 | 23% | 68% | 1.84 |

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# Table 2

## Timing of Major Patent Reforms

This table provides information about the timing of reforms in the countries that strengthen their intellectual property rights and are included in the sample.

| Country | Year of Reform |
|---|---|
| Argentina | 1996 |
| Brazil | 1997 |
| Chile | 1991 |
| China | 1993 |
| Colombia | 1994 |
| Indonesia | 1991 |
| Japan | 1987 |
| Mexico | 1991 |
| Philippines | 1997 |
| Portugal | 1992 |
| South Korea | 1987 |
| Spain | 1986 |
| Taiwan | 1986 |
| Thailand | 1992 |
| Turkey | 1995 |
| Venezuela | 1994 |

# Table 3

## Descriptive Statistics

This table provides descriptive statistics for the variables used in the analysis. The top panel provides such statistics for the analysis of affiliate activity, the middle panel for the industry analysis, and the bottom panel for the U.S. import analysis. Host Country Corporate Tax Rate and Host Country Withholding Tax Rate are annual median tax rates paid by affiliates in a host country. Host Country Inward FDI Restrictions and Host Country Capital Controls are dummies equal to one when inward FDI restrictions and capital controls exist, and they are drawn from Brune (2004) and Shatz (2000), respectively. Host Country Trade Openness is the index of constant price openness taken from Heston, Summers, and Aten (2002). The Log of Host Country GDP per capita is derived from dataprovided in the World Bank World Development Indicators. Log of Real Exchange Rate is computed using nominal exchange rates and measures of inflation from the IMF's IFS database. The Log of Parent System Sales is the log of total sales of the parent and its affiliates. Count of Initial Export Episodes is the count of HS 10 digit product categories in which the reforming country i exports to the U.S. for the first time in year t. Data are taken from the trade data base documented in Feenstra, Romalis and Schott (2001). "Tech goods" refer to the set of 10-digit commodity categories associated with innovation intensive 4-digit ISIC industries.

| ***Descriptive Statistics for Affiliate Analysis*** | Mean | Median | St. Dev |
|---|---|---|---|
| Log of Affiliate Sales | 10.6353 | 10.6472 | 1.9704 |
| Log of Affiliate Employment | 5.8123 | 5.8861 | 1.5506 |
| Log of Affiliate Net PPE | 8.6109 | 8.9343 | 2.4023 |
| Log of Intrafirm Royalty Payments | 1.6896 | 0.0000 | 3.0928 |
| Log of Affiliate R&D | 2.0742 | 0.0000 | 3.1799 |
| Host Country Corporate Tax Rate | 0.3433 | 0.3352 | 0.1290 |
| Host Country Withholding Tax Rate | 0.0833 | 0.0771 | 0.0869 |
| Host Country Inward FDI Restrictions | 0.0522 | 0.0000 | 0.2224 |
| Host Country Capital Controls | 0.0941 | 0.0000 | 0.2919 |
| Host Country Trade Openness | 34.2312 | 27.7115 | 21.1669 |
| Log of Host Country GDP per Capita | 8.9116 | 8.8417 | 0.6377 |
| Log of Real Exchange Rate | 0.0474 | 0.0394 | 0.2733 |
| Log of Parent R&D Expenditures | 11.6333 | 12.0341 | 2.8750 |
| Log of Parent System Sales | 16.0044 | 15.9771 | 1.6721 |

| ***Descriptive Statistics for Industry Analysis*** | Mean | Median | St. Dev |
|---|---|---|---|
| Log of Industry Value Added | 20.2641 | 20.2570 | 1.8232 |
| Host Country Corporate Tax Rate | 0.3049 | 0.3104 | 0.1310 |
| Host Country Inward FDI Restrictions | 0.0736 | 0.0000 | 0.2611 |
| Host Country Capital Controls | 0.1721 | 0.0000 | 0.3775 |
| Host Country Trade Openness | 42.6017 | 41.0524 | 19.9590 |
| Log of Host Country GDP per Capita | 8.6358 | 8.6712 | 0.7446 |
| Log of Real Exchange Rate | 0.0443 | 0.0372 | 0.2639 |

| ***Descriptive Statistics for U.S. Import Analysis*** | Mean | Median | St. Dev |
|---|---|---|---|
| Count of Initial Export Episodes | 908.0899 | 592.0000 | 1146.0850 |
| Count of Initial Export Episodes, "Tech" Goods | 215.7360 | 134.0000 | 279.9130 |
| Host Country Corporate Tax Rate | 0.2864 | 0.2931 | 0.1160 |
| Host Country Inward FDI Restrictions | 0.1124 | 0.0000 | 0.3167 |
| Host Country Capital Controls | 0.1067 | 0.0000 | 0.3097 |
| Host Country Trade Openness | 48.8617 | 47.0278 | 23.1988 |
| Log of Host Country GDP per Capita | 8.8562 | 8.8000 | 0.6320 |
| Log of Real Exchange Rate | 0.0442 | 0.0302 | 0.2039 |

# Table 4

## Impact of Reform on U.S. Multintional Affiliates

The dependent variables are the log of affiliate sales in column (1), the log of affiliate employment in column (2), the log of affiliate net property plant and equipment in column (3), the log of intrafirm royalty payments in column (4), and the log of affiliate research and development expenditures in column (5) The Post Reform Dummy is a dummy equal to one in the year of reform and in the years following the reforms identified in Table 2. The High Patent Use Dummy is a dummy that is equal to one for affiliates of parents that over the four years prior to a reform average at least as many patent applications as the parent of the median affiliate in the reforming country. Host Country Corporate Tax Rate and Host Country Withholding Tax Rate are annual median tax rates paid by affiliates in a host country. Host Country Inward FDI Restrictions and Host Country Capital Controls are dummies equal to one when inward FDI restrictions and capital controls exist, and they are drawn from Brune (2004) and Shatz (2000), respectively. Host Country Trade Openness is the index of constant price openness taken from Heston, Summers, and Aten (2002). The Log of Host Country GDP per capita is derived from data provided i the World Bank World Development Indicators. Log of Real Exchange Rate is computed using nominal exchange rates and measures of inflation from the IMF's IFS database. The Log of Parent System Sales is the log of total sales of the parent and its affiliates. All specifications include affiliate and year fixed effects as well as country-specific time trends. Heteroskedasticity-consistent standard errors appear in parentheses.

| Dependent Variable: | Log of Affiliate Sales | Log of Affiliate Employment | Log of Affiliate Net PPE | Log of Intrafirm Royalty Payments | Log of Affiliate R&D |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Constant | 864.3979 | 162.3100 | 21.1157 | -54.3096 | -62.9604 |
| | (99.8740) | (41.3519) | (65.2058) | (85.1728) | (106.5418) |
| Post Reform Dummy | 0.0952 | 0.0116 | 0.0365 | -0.0373 | -0.1143 |
| | (0.0379) | (0.0210) | (0.0507) | (0.0666) | (0.0917) |
| Post Reform Dummy * High Patent Use Dummy | 0.1090 | 0.0825 | 0.1195 | 0.3137 | 0.3229 |
| | (0.0404) | (0.0234) | (0.0519) | (0.0712) | (0.1020) |
| Host Country Corporate Tax Rate | 0.2953 | -0.0306 | 0.8919 | 0.0568 | 0.4978 |
| | (0.2393) | (0.1203) | (0.2730) | (0.3620) | (0.5509) |
| Host Country Withholding Tax Rate | -0.4206 | -0.1388 | 0.7351 | 0.1124 | 0.0509 |
| | (0.3160) | (0.1772) | (0.3592) | (0.4988) | (0.7491) |
| Host Country Inward FDI Restrictions | 0.0495 | 0.0558 | -0.1200 | -0.0269 | 0.0272 |
| | (0.0636) | (0.0389) | (0.0838) | (0.1303) | (0.1631) |
| Host Country Capital Controls | -0.0855 | -0.0019 | -0.0920 | -0.4938 | -0.2662 |
| | (0.0499) | (0.0239) | (0.0648) | (0.0920) | (0.1214) |
| Host Country Trade Openness | 0.0046 | -0.0023 | 0.0040 | -0.0184 | 0.0069 |
| | (0.0036) | (0.0018) | (0.0043) | (0.0051) | (0.0075) |
| Log of Host Country GDP per Capita | 1.0466 | 0.4398 | 0.5814 | 1.9406 | -0.2000 |
| | (0.2314) | (0.1212) | (0.2691) | (0.3880) | (0.6137) |
| Real Exchange Rate | -0.3627 | -0.0253 | -0.3349 | -0.2764 | -0.0976 |
| | (0.0417) | (0.0254) | (0.0548) | (0.0786) | (0.1299) |
| Log of Parent R&D Expenditures | -0.0148 | 0.0074 | 0.0503 | 0.0258 | 0.0313 |
| | (0.0093) | (0.0042) | (0.0128) | (0.0080) | (0.0118) |
| Log of Parent System Sales | 0.1533 | 0.0576 | 0.0602 | 0.0600 | -0.0243 |
| | (0.0367) | (0.0126) | (0.0235) | (0.0166) | (0.0281) |
| Affiliate and Year Fixed Effects? | Y | Y | Y | Y | Y |
| Country-Specific Time Trends? | Y | Y | Y | Y | Y |
| No. of Obs. | 17,393 | 16,991 | 14,917 | 17,737 | 10,238 |
| R-Squared | 0.8021 | 0.8932 | 0.8148 | 0.7146 | 0.6840 |

# Table 5

**Impact of Reform on Industry Value Added in Reforming Countries**

The dependent variable is the log of industry value added. The Post Reform Dummy is a dummy equal to one in the year of reform and in the years following the reforms identified in Table 2. The Technologically Intensive Dummy is equal to one for ISIC codes 351, 352, 383, 384, and 385. The Hig FDI Dummy is equal to one for industries that, in the year of reform, had above median levels of affiliate sales activity in countries with a 1980 total patent protection index above 3.57 in Ginarte and Park (1997). Host Country Corporate Tax Rate is the annual median tax rate paid by affiliates in a host country. Host Country Inward FDI Restrictions and Host Country Capital Controls are dummies equal to one when inward FDI restrictions and capital controls exist, and they are drawn from Brune (2004) and Shatz (2000), respectively. Host Country Trade Openness is the index of constant price openness taken from Heston, Summers, and Aten (2002). The Log of Host Country GDP per capita is derived from data provided in the World Bank World Development Indicators. Log of Real Exchange Rate is computed using nominal exchange rates and measures of inflation from the IMF' IFS database. All specifications include country/industry and year fixed effects as well as country-specific time trends. Heteroskedasticity-consistent standard errors appear in parentheses.

| Dependent Variable: | Log of Industry Value Added | | | | | |
|---|---|---|---|---|---|---|
| Sample | All Reforms | | | Drop China and Argentina | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Constant | 129.9846 | 130.1111 | 118.3467 | 130.8601 | 130.8772 | 119.5004 |
| | (15.6565) | (15.6084) | (15.8795) | (18.2866) | (18.2349) | (18.8760) |
| Post Reform Dummy | 0.0228 | 0.0023 | -0.0172 | -0.0024 | -0.0221 | -0.0355 |
| | (0.0171) | (0.0178) | (0.0203) | (0.0191) | (0.0198) | (0.0223) |
| Post Reform Dummy * Technologically Intensive Dummy | | 0.1133 | | | 0.1086 | |
| | | (0.0249) | | | (0.0274) | |
| Post Reform Dummy * High FDI Dummy | | | 0.0911 | | | 0.0869 |
| | | | (0.0215) | | | (0.0239) |
| Host Country Corporate Tax Rate | -0.1325 | -0.1330 | -0.0980 | -0.0666 | -0.0664 | -0.0492 |
| | (0.1109) | (0.1108) | (0.1147) | (0.1291) | (0.1290) | (0.1341) |
| Host Country Inward FDI Restrictions | -0.2262 | -0.2260 | -0.2178 | -0.2171 | -0.2166 | -0.2132 |
| | (0.1007) | (0.1010) | (0.1093) | (0.1009) | (0.1012) | (0.1094) |
| Host Country Capital Controls | 0.1065 | 0.1066 | 0.0820 | 0.2238 | 0.2236 | 0.1982 |
| | (0.0333) | (0.0334) | (0.0340) | (0.0332) | (0.0333) | (0.0335) |
| Host Country Trade Openness | 0.0012 | 0.0011 | 0.0003 | 0.0008 | 0.0008 | -0.0006 |
| | (0.0023) | (0.0023) | (0.0023) | (0.0029) | (0.0028) | (0.0029) |
| Log of Host Country GDP per Capita | 2.2089 | 2.2110 | 2.1203 | 2.4761 | 2.4761 | 2.4205 |
| | (0.1494) | (0.1491) | (0.1557) | (0.2010) | (0.2005) | (0.2135) |
| Log of Real Exchange Rate | -0.3724 | -0.3725 | -0.3539 | -0.4354 | -0.4355 | -0.4117 |
| | (0.0324) | (0.0323) | (0.0314) | (0.0413) | (0.0412) | (0.0397) |
| Country/Industry, and Year Fixed Effects? | Y | Y | Y | Y | Y | Y |
| Country-Specific Time Trends? | Y | Y | Y | Y | Y | Y |
| No. of Obs. | 6,884 | 6,884 | 6,183 | 6,069 | 6,069 | 5,427 |
| R-Squared | 0.9593 | 0.9595 | 0.9581 | 0.9584 | 0.9585 | 0.9569 |

## Table 6

### Impact of Reform on Initial Export Episodes

The dependent variable is the count of HS 10 digit product categories in which the reforming country i exports to the U.S. for the first time in year t. These count data are available for the years 1989-2002; the sample covers 1989-1999 to ensure consistency with our other regressions. Data are taken from the trade data base documented in Feenstra, Romalis and Schott (2001). "Tech goods" refer to an alternative count of initial export episodes that take place only within SITC 5-digit (revision 2) industries that are characterized by a substantial degree of innovative activity. The Post Reform Dummy is equal to one in the year of reform and in the years following the reforms listed in Table 2. Host Country Corporate Tax Rate is the annual median tax rate paid by affiliates. Host Country Inward FDI Restrictions and Host Country Capital Controls are dummies equal to one when inward FDI restrictions and capital controls exist, and they are drawn from Brune (2004) and Shatz (2000), respectively. Host country Trade Openness is the index of constant price openness taken from Heston, Summers, and Aten (2002). The Log of Host Country GDP per capital is derived from data provided in the World Bank World Development Indicators. The Log of the Real Exchange Rate is computed using nominal exchange rates and measures of inflation from the IMF's IFS database. All specifications include country and year fixed effects.

| Dependent Variable: | Count of Initial Export Episodes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Specification Type: | Poisson | | | | Negative Binomial | | | |
| Sample: | All Reforms | | Drop Argentina and China | | All Reforms | | Drop Argentina and China | |
| Goods Categories | All Goods | Tech Goods | All Goods | Tech Goods | All Goods | Tech Goods | All Goods | Tech Goods |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Post Reform Dummy | 0.224 | 0.2328 | 0.2319 | 0.2954 | 0.1753 | 0.1591 | 0.183 | 0.2036 |
| | (0.0090) | (0.0186) | (0.0101) | (0.0214) | (0.0584) | (0.0867) | (0.0670) | (0.1027) |
| Host Country Corporate Tax Rate | 0.0899 | 0.2859 | -0.0912 | -0.1188 | -0.3097 | -0.6362 | -0.2686 | -0.3357 |
| | (0.0585) | (0.1230) | (0.0720) | (0.1531) | (0.3496) | (0.4975) | (0.4368) | (0.6096) |
| Host Country Inward FDI Restrictions | -0.03 | 0.0287 | -0.0454 | -0.0468 | -0.1032 | -0.0746 | -0.126 | -0.1238 |
| | (0.0192) | (0.0359) | (0.0203) | (0.0382) | (0.1207) | (0.1768) | (0.1269) | (0.1829) |
| Host Country Capital Controls | -0.252 | -0.3754 | -0.1919 | -0.2381 | -0.1653 | -0.0942 | -0.2001 | -0.1869 |
| | (0.0224) | (0.0365) | (0.0168) | (0.0413) | (0.0900) | (0.1440) | (0.1078) | (0.1815) |
| Host Country Trade Openness | 0.0111 | 0.014 | 0.0114 | 0.01268 | 0.0061 | 0.0051 | 0.0088 | 0.0097 |
| | (0.0006) | (0.0011) | (0.0006) | (0.0011) | (0.0032) | (0.0039) | (0.0035) | (0.0044) |
| Log of Host Country GDP per Capita | -0.077 | 0.1273 | -0.0193 | 0.5887 | -0.1921 | -0.2325 | -0.0458 | 0.047 |
| | (0.0318) | (0.0623) | (0.0442) | (0.0890) | (0.1605) | (0.2103) | (0.1929) | (0.2492) |
| Log of Real Exchange Rate | 0.1728 | -0.0028 | 0.2029 | -0.0606 | 0.1484 | -0.0778 | 0.1514 | -0.0787 |
| | (0.0197) | (0.0395) | (0.0220) | (0.0443) | (0.1267) | (0.1858) | (0.1450) | (0.2079) |
| Country and Year Fixed Effects? | Y | Y | Y | Y | Y | Y | Y | Y |
| No. of Obs. | 178 | 178 | 156 | 156 | 178 | 178 | 156 | 156 |
| Log Likelihood | -3962 | -2196 | -3751 | -2032 | -1033 | -861 | -909 | -756 |