INTELLECTUAL PROPERTY RIGHTS, IMITATION, AND FOREIGN DIRECT INVESTMENT: THEORY AND EVIDENCE

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ABSTRACT

This paper theoretically and empirically analyzes the effect of strengthening intellectual property rights in developing countries on the level and composition of industrial development. We develop a North-South product cycle model in which Northern innovation, Southern imitation, and FDI are all endogenous. Our model predicts that IPR reform in the South leads to increased FDI in the North, as Northern firms shift production to Southern affiliates. This FDI accelerates Southern industrial development. The South's share of global manufacturing and the pace at which production of recently invented goods shifts to the South both increase. Additionally, 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 test the model's predictions by analyzing responses of U.S.-based multinationals and domestic industrial production to IPR reforms in the 1980s and 1990s. First, we find that MNCs expand the scale of their activities in reforming countries after IPR reform. MNCs that make extensive use of intellectual property disproportionately increase their use of inputs. There is an overall expansion of industrial activity after IPR reform, and highly disaggregated trade data indicate an increase in the number of initial export episodes in response to reform. These results suggest that the expansion of multinational activity more than offsets any decline in the imitative activity of indigenous firms.

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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? On the one hand, effective enforcement of IPR confers monopoly power on the creators of intellectual property, generating a static welfare loss. In addition, opponents of IPR reform in developing countries argue that stronger IP enforcement will hamper the ability of local firms to experiment with and assimilate advanced foreign technologies at low cost and hence slow down the rate of global technological diffusion.[1] By contrast, proponents of stronger IPR argue that it may actually enhance the industrial development process in developing countries since the provision of greater security for intellectual property in developing countries will encourage multinationals to shift production to such countries. This assumes that the decline in indigenous imitative activity in developing countries that institute IPR reforms can, in principle, be offset by increased multinational activity. Proponents also argue that stronger IPR enforcement in developing countries will lead to increased world wide innovation, benefitting consumers everywhere. This paper seeks to illuminate this debate by modeling 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).

Our 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.[2] In Helpman's model, stronger IPR in the South significantly retards Southern industrial development. The South's share of global manufacturing is lower in the strong IPR equilibrium, and the rate at which the

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[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. 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). For criticisms of strong IPR which stress static welfare losses, see McCalman (2001) and Chaudhuri et al. (2006).

[2] Subsequent work has retained this assumption; to maximize continuity with this earlier work, so do we. 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 (2006), Scherer and Weisburst (1995), and Sakakibara and Branstetter (2001) all suggest weak effects.

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. Thus, the retardation of Southern industrial development also leads to a decline in the rate of Northern innovation. Furthermore, under Helpman's assumptions, 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. Instead, Northern 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.[3] Making both imitation and FDI endogenous increases our model's complexity, but allows 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

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[3] 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."

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 activities in reforming countries after IPR reform. Affiliates of parents that make extensive use of intellectual property in countries that do not reform disproportionately increase their physical capital, employment compensation, transfer of technology from abroad, and research and development (R&D) expenditures. This evidence is consistent with U.S. multinationals shifting production of more technologically intensive goods to affiliates in response to reforms.

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. Thus, it appears that increased multinational activity is sufficiently large to offset potential declines in imitative local activity, suggesting an overall enhancement of Southern industrial development. This is important for assessing the overall welfare impact of IPR reforms, since the theory argues that increased Southern industrial development is a necessary condition for reforms to be welfare improving. We obtain further indirect evidence on the rate at which production of goods is transferred to reforming countries 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. 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.

The rest of the paper is organized as follows: In Section 2 we present our theoretical model. Section 3 describes our data and presents our empirical results. Section 4 concludes.

2 Theory

The North-South product cycle model we present here 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. Our primary goal 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. To preview our findings, 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 impact of the second effect on Southern industrialization 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 set of clear, empirically testable hypotheses 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:

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

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subject to the intertemporal budget constraint

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

where ρ 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

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

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, he chooses how to allocate a given spending level across all available goods. Second, he 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

$$x(j) = \frac{E p(j)^{-\varepsilon}}{P^{1-\varepsilon}} \qquad (4)$$

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

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

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

$$\frac{\dot{E}}{E} = r - \rho \qquad (6)$$

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. A firm needs 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. Intuitively, this is due to the costs of coordinating decisions over large distances and operating in relatively unfamiliar environments 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 μ denote the rate of imitation (defined in equation 17) and as in Lai (1998) assume that imitation targets only Northern multinationals. As is 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. In our model, the risk faced by Northern firms that do not produce in the South has been normalized to zero.[4] In reality, Northern firms that do not undertake FDI can also have their technologies imitated, but the risk of imitation they face is probably lower than that of multinational firms that produce in the South.

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 if and only if its unconstrained monopoly price $\frac{w^S}{\alpha}$ exceeds the multinational's marginal cost θw^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 $\theta \alpha < 1$.

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

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

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[4]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.

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 ϕn_N at each instant. Let the rate of imitation μ be defined by

$$\mu \equiv \frac{\dot{n}_I}{n_M} \tag{17}$$

i.e. μ 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:

$$g \equiv \frac{\dot{n}}{n} = \frac{\dot{n_N}}{n_N} = \frac{\dot{n_I}}{n_I} = \frac{\dot{n_M}}{n_M} = \frac{\dot{n_S}}{n_S} \qquad (18)$$

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

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

Similarly,

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

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:

$$v^N = \frac{\pi^N}{\rho + g} \qquad (21)$$

while that of one that chooses to become a multinational equals

$$v^M = \frac{\pi^M}{\rho + \mu + g} \qquad (22)$$

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

$$v^N = v^M \qquad (23)$$

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

$$v^S = \frac{\pi^S}{\rho + g} \qquad (24)$$

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 (θ) as well as with the Southern rate of imitation (μ) since both of these factors encourage Northern firms to produce in the North (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

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

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

$$c_I = \frac{w^S a_I}{n_S} \qquad (31)$$

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

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

Substituting from (24) into the above equation gives

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

Using (11) gives

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

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

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

Substituting from (13) and (14) gives

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

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

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

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

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

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:

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

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

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

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

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

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

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

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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 μ, and the rate of FDI ϕ. 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 (μ) 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 (ϕ) or the Northern rate of innovation (g) as well as those that lower the Southern rate of imitation (μ) will increase the value of multinational sales relative to those of Northern firms.

Assuming the rate of imitation μ is exogenously given, Lai (1998) has shown that *a strengthening of Southern IPR protection (i.e. a decline in μ) increases Northern innovation (g) and the rate of production shifting to the South.*[5] Here, we address the question of whether the above result holds when imitation is endogenous and the underlying exogenous variable is the cost of imitation a_I. To do so, we first solve equation (38) for FDI flow ϕ in terms of the other two endogenous variables (g and μ) 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

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

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

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where

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

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

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

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 $\left(\frac{n_S}{n} \right)$ that occurs in the South. Otherwise the cost of imitation would 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

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

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

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

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 μ must also increase the demand for Southern labor. A similar statement can be made about the rate of innovation:

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

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

Thus, the Southern labor market constraint is downward sloping in the (g, μ) 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 μ 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 μ, higher the demand for Northern labor.

While the expression for $\frac{\partial L^N(\mu,g)}{\partial g}$ is complicated, it has a positive sign for most reasonable parameter values. Thus, the Northern labor market constraint is also downward sloping in the (g, μ) 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, μ) 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.

We may question the assumption that production workers could be easily redeployed as R&D workers, and this issue warrants further discussion. In keeping with the prior stream of theoretical research, 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, and then invest some of the resources saved in higher levels of R&D. In an 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 engage in more innovative activities than their global rivals. Throughout the period under study, U.S.-based firms retained their leadership of global market share. Manufacturing shifted almost entirely offshore and high-level

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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. Thus, 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 consider how an increase in the cost of imitation impacts both of the labor market constraints, as represented in the paper. From equation (42) it is immediate that holding constant the rates of imitation and growth (i.e. μ 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, μ) space.

From equation (40) we note that holding constant g and μ, an increase in a_I effects the Northern labor market constraint via its effect on the rate of FDI ϕ. Given that the flow of FDI ϕ 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 μ decreases.[6]

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

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[6]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.

(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 $\alpha = 1/2$).[7]

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 as follows: A strengthening of Southern IPR protection makes imitation less attractive, thereby lowering the rate of imitation μ. A lower risk of imitation makes FDI in the South more attractive to Northern firms who respond by increasing the rate of FDI (ϕ) which translates into a higher share of FDI in Southern production $(\frac{n_M}{n_S})$. Also, note that as Southern IPR is strengthened, the South ends up producing a greater percentage of the world's basket of goods $(\frac{n_S}{n})$. This occurs 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 the cost of imitation causes the South's share of total manufacturing to more than quadruple. Due to the FDI response, the growth in Southern production is also faster than in a weak IPR equilibrium. In addition, stronger IPR raises the relative wage of Southern workers.[8] In Table 1a, a 40% increase in the costs of imitation 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.

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[7]Tables 1b and 1c in the appendix show that the results reported in Table 1 are robust to variations in θ.

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

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. We now turn to our 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, through the channel of multinational production shifting. Three predictions that follow from the theory can be tested empirically. First, according to the theory, 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 activity that was occurring prior to reform. Finally, the pace at which multinationals introduce the production of new products to their affiliates accelerates following reform.

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 (2006), 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.[9] As in Branstetter, Fisman, and Foley (2006), we assume that the precise timing of the regime changes is exogenous to the activities of the individual firms.[10] 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 fea-

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[9] A detailed discussion of the particulars of these sixteen reform episodes is provided by Branstetter, Fisman, and Foley (2006) and the accompanying Data Appendix. Both documents can be downloaded from http://www.heinz.cmu.edu/branstet. 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.

[10] Branstetter, Fisman, and Foley (2006) 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. See pages 342-347.

tures 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.[11]

Note that we include patent reforms in Japan in our sample, though it is a high income 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 frontier.[12] 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.

3.1   Multinational Firm Responses

3.1.1   Empirical Specification

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 MNE activity changes around the time of reform. The 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:

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

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

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[11] 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.

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

multinational activity serve as dependent variables. In the theory section, the concept of "scale of multinational activity" is unambiguously defined, and it corresponds to the number of distinct products for which production has shifted to the South. While our data on multinational activity are at the affiliate level, they do not include sales data broken down by individual products. Hence, our data are not sufficiently disaggregated to measure production shifting directly. However, by measuring the response of multinational affiliates to IPR reform along a number of dimensions, we can look for evidence of a change in affiliate behavior consistent with production shifting, as defined in our theoretical model. To capture indirect evidence of production shifting, we measure affiliate's capital stock, employment compensation, use of technology from the parent firm, and R&D expenditures. To further sharpen our inference, we allow the nature of an affiliate's response to patent reform to differ depending on the intensity with which the parent firm deploys intellectual property in countries that do not undertake a reform.

The key variables of interest are R_{jt}, the post reform dummy variable, and R_{jt} interacted with a variable, $Tech_{il}$, that reflects the extent to which parent firms transfer technology to affiliates in countries that do not reform their IPR. R_{jt} is equal to one in the year of and years following patent reform in country j. $Tech_{il}$ is generated as follows: those affiliates of parents that, over the four years prior to a particular reform, receive at least as much technology licensing income from their affiliates outside the reforming countries as the parent of the median affiliate in the reforming country over the same period are assigned a high technology transfer dummy, $Tech_{il}$, equal to one. For other affiliates, $Tech_{il}$ equals zero. This dummy variable thus captures the relative propensity of different parent firms to both create intellectual property and deploy it outside the home country. It is intuitive that firms with a greater dependence on intellectual property should respond more strongly to IPR reforms, so that $\beta_4 > 0$.

We include a number of controls. α_{il} are time-invariant fixed effects for the affiliate, α_t are year fixed effects for the entire sample, and y_{jt} are 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, real exchange rates and corporate tax rates. We do not view this basic specification as a structural production function (or investment equation) in any sense, nor do we impute structural interpretations to any of the regression parameters generated by such a specification.

In seeking to measure changes in the scale of multinational operations after IPR reform, we note that use of what is perhaps the most obvious measure – sales – presents serious problems of inference. Because a strengthening of IPR raises the effective monopoly power of patent holders, it is likely to increase the pricing power of foreign multinationals. If multinational affiliates increase sales after IPR reform – and we do find evidence of a post-reform sales increase on the order of 17% – this could indicate an increase in production shifting. However, it could just as easily reflect the fact that affiliates exploit the increased monopoly power conferred on them through IPR reform by charging higher markups on an unchanged set of products. In the absence of firm-specific price indices, we would be unable to rule out this alternative explanation. Therefore, our analysis of firm-level data will emphasize the use of measures of inputs to the production process rather than measures of output. If there is at least a group of firms that substantially increases their capital stock after IPR reform, this would be consistent with an expansion of affiliate activity along the dimensions stressed by the theory. We might also expect to see an increase in the utilization of labor. In our theory, in which labor is the only factor, this would be a natural implication. In practice, production shifting of more technologically sophisticated goods might have a relatively modest effect on the overall size of the workforce and much more of an impact on its composition; the firm might change the skill mix of its affiliate workforce, hiring more managers and engineers. While we do not have direct measures of skill mix, we do have measures of total employment compensation, which would reflect a shift in the composition of the labor force toward higher-skilled (and higher-paid) workers.

In a similar manner, the inception of production of more sophisticated products would be likely to require an increase in the use of the parent firm's technology. Following Branstetter, Foley, and Fisman (2006), we can use affiliate level data on the volume of intrafirm royalty payments for intangible assets to track changes in the licensing of technology from the parent.[13] If IPR reform induces firms to shift production of more technologically intensive products to affiliates in reforming countries, we would expect to see those payments increase relative to affiliate sales. Finally, the inception of production of more technologically intensive products should be associated with an increase in affiliate level R&D spending. There is a considerable body of work that details the relationship between affiliate and parent-firm

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[13]Our earlier paper describes at length the nature of these data and the issues that arise in using them as indicators of technology transfer. See pages 328-330 of Branstetter, Fisman, and Foley (2006) for details.

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 (see, for example, Kummerle, 1999). Thus, affiliate R&D and technology transfers from the parent should be considered complements so that IPR reform should also generate an increase in R&D spending.

3.1.2 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 compensation, 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 technology for 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. 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.

3.1.3 Results

Table 4 presents the results of specifications based on equation (53) that test if affiliates expand their operations at the time of reform. As noted above, our tests focus on measures of input to affiliate production, because of the difficulties in interpreting changes in measured sales. The dependent variable in column 1 is the log of the level of affiliate assets. The 0.1114 coefficient on the IPR Reform dummy indicates that affiliates of U.S. MNEs expand their capital stock at the time of reform. Since the dependent variable is measured in logs, these coefficients have a semi-elasticity interpretation, implying that these affiliates increase their capital stock by about

11% following reforms. The IPR Reform dummy interacted with the High Technology Transfer dummy is positive and statistically significant, indicating that the affiliates of parents that extensively deploy intellectual property in countries that do not reform their IPR expanded their capital stock by an additional 9%. Thus, in line with our predictions, IPR reforms trigger increases in affiliate assets, and these increases are larger among firms that are especially likely to value reforms.

The second column of Table 4 presents results of the same specification, with the log of physical capital (net PPE) used in place of the log of assets as the dependent variable. This provides us with an alternative measure of affiliates' capital stock. The coefficient on the reform dummy is small and statistically insignificant at conventional levels. However, the coefficient on the reform dummy interacted with the High Technology Transfer dummy is large and statistically significant. This result implies that affiliates of firms that transfer technology abroad extensively increase their stock of physical capital by nearly 19% more than other affiliates following reform.

The third column presents estimates of the impact of reform on employment compensation. The coefficient on the reform dummy is positive and statistically significant, suggesting a roughly 12% increase in labor compensation. The coefficient on the interaction term of the reform dummy with the High Technology Transfer dummy is also positive and statistically significant, suggesting a total expansion of around 20% for affiliates of firms that make extensive use of intellectual property.

While the results of the first three columns all imply an expansion of multinational activity in the wake of patent reform, they do not necessarily imply an acceleration in the rate at which the production of new goods is transferred to the South. However, the production of new goods is likely to require new technology from the parent firm, and to examine this hypothesis, we analyze royalties paid by affiliates to parents for the sale or use of intangible assets. Because larger affiliate sales volumes may automatically result in higher levels of royalty payments back to the parent, we use the log of the royalty to sales ratio. For expositional purposes, we multiply this value by 100 in our reported results. Results similar to those on royalty payments and R&D expenditure were previously reported in Branstetter, Fisman, and Foley (2006) in empirical work that focused specifically on this component of firms' reaction to IPR reforms. We provide royalty results in column 4 of Table 4. The coefficient on the reform dummy is actually negative and, at conventional levels, statistically significant. However, the coefficient on the interaction term is positive, highly significant, and large in magnitude. For the affiliates of firms that are more dependent on the use of

parent technology abroad, royalty payments appear to increasing substantially. Increased licensing payments, cumulated over several years, would imply a substantial increase in the technological intensity of activity undertaken by these affiliates. Alternative specifications using the level of royalty payments as the dependent variable produced qualitatively similar results.

Column 5 shows the results of a specification using affiliate R&D spending. While most R&D spending by U.S.-based multinational firms is concentrated in the U.S., some foreign affiliates have substantial R&D expenditures. As noted above, 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 we would expect that increase to be mirrored by an increase in affiliate R&D spending. In column 5 of Table 4, we show results of a specification using the log of affiliate R&D expenditure divided by affiliate sales as the dependent variable (as in column 4 we multiply the log of the ratio by 100 for expositional purposes). The coefficient on the reform dummy is small and statistically indistinguishable from zero at conventional levels. However, the interaction of the reform and High Technology Transfer dummy is positive and statistically significant; for affiliates of parents that are likely to especially value strong IPR, there is a significant post reform increase in affiliate R&D. Alternative specifications using the log of R&D spending generated qualitatively similar results.

As noted previously, 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 repeated the specifications shown in Table 4 with a restricted sample that excluded Argentina and China. We obtained results qualitatively similar to those shown here.[14] Because Japan differs in important ways from the other countries that undertook significant IPR reforms, we dropped Japan from the sample. Our results were not qualitatively affected by this. Our results were also robust to the inclusion of region-year fixed effects. Concerns that measurement of the High Technology Transfer dummy might cause it to proxy for firm size led us to incorporate an interaction term of firm size and patent reform. This did not affect our

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[14] These results are available from the authors upon request. The only specifications that were sensitive to the exclusion of Argentina and China were those that employed the log of the R&D/Sales ratio as the dependent variable.

results.

Taken together, these results strongly suggest a pattern of responses to IPR reform that is consistent with the kind of production shifting emphasized in our theoretical model. While the results of any one specification are subject to multiple interpretations, our collective results suggest the mechanism sketched out by our theoretical model is operative in the real world generating our data. Is this positive effect sufficiently strong to have a positive effect overall on industrial development in reforming countries? To better get at this issue, we turn to industry-level data from the reforming countries.

3.2   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 analyses do not indicate the consequences of reform for multinationals from other countries or for local firms. Our model predicts an overall increase in industrial production, as Southern industrial development accelerates and the share of global manufacturing in the South rises. We should observe sufficiently high 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, it is possible to analyze broad economic changes using industry-wide measures of production in reforming countries.

3.2.1   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:

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

where VA measures value added in industry i in country j in year t. The controls include 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. In some specifications we allow the impact of IPR reform to

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differ according to the importance of technological innovation for firms (both multinational and domestic) by interacting R_{jt} with an industry-level measure of technology intensity. We set the Technology Intensive dummy equal to one for the following industries: electrical machinery, industrial chemicals, other chemicals, professional and scientific equipment, and transportation equipment. As an alternative approach, we also generate an industry-level measure of FDI intensity by looking at the cross-industry distribution of U.S. FDI in countries where intellectual property is well protected throughout our sample. The intuition is that these are the sectors where multinationals would naturally choose to invest abroad. We generate a dummy variable that denotes industries that had above median affiliate sales in this set of high IPR countries. If the impact of reform is particularly strong in these sectors, we expect a positive coefficient on the interaction of this measure of IPR importance with our post-reform dummy variable.[15]

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 are 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.

3.2.2 Results

Table 5 reports results from specification (54) on industry level value added measures obtained from the UNIDO 3-digit industry-level database. The positive coefficient on the reform dummy in the first column implies that growth in value added accelerates after patent reform, but this effect is not statistically significant at conventional levels. Column two reports a specification that includes the interaction of the reform dummy and the Technology Intensive dummy. The interaction term is positive and statistically significant, implying that the output expansion suggested by the results in column one is concentrated in technology intensive industries. This argues

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[15] 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.

against the view that IPR reform induces a collapse of indigenous industrial activity that more than offsets MNC expansion. Rather, the point estimate implies an expansion of industry level value added, relative to the underlying trend, of more than 11%. Results from column 3, in which reform is interacted with a dummy variable that identifies the industries in which U.S. FDI is concentrated worldwide, further bolsters this view. Again, we find that the interaction term is positive and statistically significant. As in our earlier results, we repeat our analyses dropping China and Argentina from the analyses, and obtain qualitatively similar results (see columns 4-6).

3.3   Initial Export Episodes

Interpreted literally, our model's predictions center on the inception of production of new goods following reform. Measures of affiliate or industry activity analyzed above are not sufficiently disaggregated to permit the tracking of affiliate activity at the individual product level. Therefore, to capture more directly the extent of new production initiation in reforming countries, we use an approach inspired by Feenstra and Rose (2000).

This approach requires the use of disaggregated U.S. import statistics to obtain counts of initial export episodes. Specifically, we use 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. 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, thus measured, is more rapid after patent reform, as predicted by our model.

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 production shifting.[16]

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[16] Note, however, there is evidence that the expected cessation of production of certain

3.3.1 Empirical Approach and Data

Our dependent variable P is a count variable that measures, for a given country j in a given year t, the number of 10-digit commodities that were exported to the U.S. for the first time. Intuitively, this is a proxy for the arrival rate of new products. This count is regressed on country-year variables that control for a country's changing export capabilities using a specification that includes country dummy variables, time dummy variables, a vector of time-varying characteristics of country j, and the reform dummy variable:

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

The country characteristics are the same as those used in the previous table.[17] A positive coefficient on the reform dummy would indicate that reforms spur the rate at which new products are produced in reforming countries, indicating 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 are 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.

We use data from the U.S. trade database created by Feenstra, Romalis, and Schott (2001). Annual data on U.S. imports from nearly all countries worldwide are available at the 10-digit level of disaggregation, which is very close to the individual product level. One difficulty in using 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 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

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goods in the U.S. is taking place. A recent study by Bernard, Redding, and Schott (2006) 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) for 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.

[17]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; hence, there is less need to include country-specific time trends.

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 mask many of the new product introductions that we are trying to measure. We therefore focus on the post-1988 years for which our data are measured consistently.[18] Descriptive statistics for the data employed in our analysis are provided in the bottom panel of Table 3.[19] As in our earlier specifications, we can examine whether the estimated impact of IPR reform is stronger in technology intensive product categories. This is done by limiting our analysis to HS 10-digit product categories that can be associated with the ISIC codes identified in the previous section as being technology intensive: electrical machinery, industrial chemicals, other chemicals, professional and scientific equipment, and transportation equipment. For all country-year observations, we create separate counts of initial export episodes arising in only these product categories. We refer to these product categories as "tech goods" and use this term to designate regression results based on this subsample of the data.

3.3.2   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. In column 1 we provide results using the Poisson fixed effects regression model derived by Hausman, Hall, and Griliches (1984) that accounts for the count nature of the dependent variable. In this specification, we use data on initial export episodes in all product categories and in all reforming countries. The 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 21%.

In column 2, we continue to employ a Poisson fixed effects model, but limit the sample to product classes associated with technology intensive industries. If the post-reform acceleration in production-shifting is driven,

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[18]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 measured consistently in this broader sample.

[19]These data contain some observations that record extremely small trade flows, often followed by no activity. Concerned that these anomalous observations might bias upward the counts of initial export episodes, we report results obtained when we drop these questionable observations, though we obtain qualitatively similar results with the full data set.

at least in part, by the reaction of multinationals to stronger IPR, then we would expect to see effects in this subsample that are at least as large as those obtained from the whole sample. When we do so, we obtain an effect that is positive and statistically significant. The point estimate is slightly larger in magnitude than that in column 1. As in previous regressions, we repeat the analyses excluding Argentina and China, and obtain similar results (columns 3 and 4). Finally, following Hausman, Hall, and Griliches (1984), we also employ their fixed effects negative binomial model as an alternative specification and obtain similar results to those derived from the Poisson model (columns 5-8).

4 Conclusion

The strengthening of IPR in the developing world remains controversial. 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.

The theoretical literature initiated by Helpman (1993) has shown that the ultimate effect of IPR reforms 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 when Northern innovation, Southern imitation, and FDI are all endogenous.

These theoretical results open 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 data on the activities of U.S. multinational affiliates, industry-level data from reforming countries, and U.S. import data. All of the evidence indicates that stronger IPR in the South *accelerates* the rate at which multinational production is 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, and we argue that 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 amount of production shifting. Evidence from industry-level value-added data and from highly disaggregated U.S. trade data strongly suggest that this does not occur. Rather, data measuring levels of industry activity and initial export episodes of tradable goods 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 especially expands 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.

Over the long run, production shifting should free up Northern resources for investment in innovative activity. In this paper, we do not attempt to estimate the magnitude or timing of this longer run, general equilibrium effect. 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, those based in the U.S. appear to have increased their generation of new ideas.[20] Along with this surge in innovative outcomes has come an acceleration in total factor productivity growth – an acceleration which has persisted in recent years.[21] 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.

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[20]See Kortum and Lerner (1999) for a discussion of evidence based on patent data.

[21]See Gordon (2003) and the studies cited therein.

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 θ.

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 σ where

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

as the rate of multinationalization. However, σ 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 multi-nationals ought to count as those that have been multinationalized. The other products made in the South are those that have been imitated by 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 μ is exogenous simplifies our model down to Lai's. In that case, the two endogenous variables (i.e. g and ϕ) 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 μ) 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 θ

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 θ (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 θ weakens the incentives for FDI whereas it strengthens the incentives for imitation. In Table 1b $\theta = 1.25$ whereas in Table 1c, $\theta = 1.35$.[22] As can be seen from Tables 1a-1c, the bigger is θ, the smaller the extent of FDI and larger the Northern relative wage. The intuition is that when θ 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.

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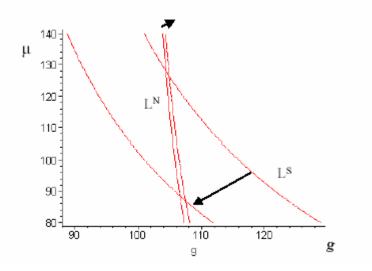
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[22]Recall that in Table 1a, $\theta = 1.3$.

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Figure 1   Effects of Southern IPR Protection

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 data provided in the World Bank World Development Indicators. Log of Real Exchange Rate is computed using nominal exchange rates and measures of inflation are 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 a reforming country exports to the U.S. for the first time in a given year. 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, specifically industries in ISIC codes 351, 352, 383, 384, and 385.

Descriptive Statistics for Affiliate Analysis	Mean	St. Dev
Log of Affiliate Assets	10.4941	1.4575
Log of Affiliate Employment Compensation	8.5501	1.5427
Log of Affiliate Net PPE	8.3119	2.6142
100 X Log of Intrafirm Royalty Payments/ Affiliate Sales	0.5365	1.5060
100 X Log of R&D Expenditures/Affiliate Sales	0.3741	1.0702
Host Country Corporate Tax Rate	0.3414	0.1289
Host Country Withholding Tax Rate	0.0831	0.0883
Host Country Inward FDI Restrictions	0.0526	0.2233
Host Country Capital Controls	0.0915	0.2883
Host Country Trade Openness	34.1400	21.2664
Log of Host Country GDP per Capita	8.9012	0.6336
Log of Host Country GDP	26.7154	1.3799
Log of Real Exchange Rate	0.0531	0.2693
Log of Parent R&D Expenditures	10.5503	4.0110
Log of Parent System Sales	15.7507	1.8310

Descriptive Statistics for Industry Analysis	Mean	St. Dev
Log of Industry Value Added	20.3981	1.9422
Host Country Corporate Tax Rate	0.3048	0.1310
Host Country Inward FDI Restrictions	0.0736	0.2611
Host Country Capital Controls	0.1723	0.3777
Host Country Trade Openness	42.5896	19.9606
Log of Host Country GDP per Capita	8.6352	0.7447
Log of Real Exchange Rate	0.0441	0.2640

Descriptive Statistics for U.S. Import Analysis	Mean	St. Dev
Count of Initial Export Episodes	608.2804	1009.8990
Count of Initial Export Episodes, "Tech" Goods	105.5661	186.4544
Host Country Corporate Tax Rate	0.2864	0.1160
Host Country Inward FDI Restrictions	0.1124	0.3167
Host Country Capital Controls	0.1067	0.3097
Host Country Trade Openness	48.8617	23.1988
Log of Host Country GDP per Capita	8.8562	0.6320
Log of Real Exchange Rate	0.0442	0.2039

Table 4

U.S. Multinational Affiliate Responses to Reform

The dependent variables are the log of affiliate assets in column (1), the log of affiliate net property plant and equipment in column (2), the log of affiliate employment compensation in column (3), 100 times the the log of one plus the ratio of intrafirm royalty payments to affiliate sales in column (4), and 100 times the log of the ratio of one plus the ratio of affiliate research and development expenditures to affiliate sales 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 Technology Transfer Dummy is a dummy that is equal to one for affiliates of parents that over the four years prior to a reform average total royalty payment receipts from all affiliates that are at least as large as the receipts of 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). 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 and Log of Host Country GDP are derived from data provided in the World Bank *World Development Indicators* (2003). Log of Real Exchange Rate is computed using nominal exchange rates taken from Heston, Summers, and Aten (2002) 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 Assets	Log of Affiliate Net PPE	Log of Affiliate Employment Compensation	100 X Log of Intrafirm Royalty Payments/ Affiliate Sales	100 X Log of R&D Expenditures/ Affiliate Sales
	(1)	(2)	(3)	(4)	(5)
Post Reform Dummy	0.1114	0.0245	0.1210	-0.1311	-0.0129
	(0.0173)	(0.0430)	(0.0205)	(0.0274)	(0.0252)
Post Reform Dummy * High Technology Transfer Dummy	0.0912	0.1882	0.0790	0.3985	0.0546
	(0.0181)	(0.0443)	(0.0217)	(0.0323)	(0.0275)
Host Country Corporate Tax Rate	0.1361	0.5099	0.4746	-0.0286	0.2966
	(0.0985)	(0.2370)	(0.1104)	(0.1680)	(0.1432)
Host Country Withholding Tax Rate	0.3365	0.4473	-0.4565	-0.5657	0.3879
	(0.1387)	(0.3135)	(0.1646)	(0.2324)	(0.1783)
Host Country Inward FDI Restrictions	-0.0601	-0.0971	-0.0483	0.0407	-0.0735
	(0.0386)	(0.0748)	(0.0327)	(0.0512)	(0.0480)
Host Country Trade Openness	0.0062	0.0071	0.0001	-0.0074	0.0016
	(0.0016)	(0.0035)	(0.0016)	(0.0029)	(0.0020)
Log of Host Country GDP per Capita	0.3406	0.7166	0.4713	0.6963	0.0196
	(0.1518)	(0.2908)	(0.1900)	(0.3193)	(0.4135)
Log of Host Country GDP	0.9037	-0.1374	0.6179	-0.0007	-0.0537
	(0.1632)	(0.3226)	(0.1924)	(0.3339)	(0.4109)
Real Exchange Rate	-0.3161	-0.3231	-0.3657	-0.1097	0.0578
	(0.0198)	(0.0483)	(0.0238)	(0.0401)	(0.0373)
Log of Parent R&D Expenditures	0.0076	0.0315	0.0054	0.0072	0.0072
	(0.0035)	(0.0089)	(0.0040)	(0.0040)	(0.0027)
Log of Parent System Sales	0.0467	0.0555	0.0601	0.0058	-0.0015
	(0.0088)	(0.0143)	(0.0093)	(0.0092)	(0.0039)
No. of Obs.	26,184	22,342	24,844	25,600	16,143
R-Squared	0.8884	0.8377	0.8789	0.6651	0.6645

Table 5

Impact of Reform on Industry Value Added in Reforming Countries

The dependent variable is the log of industry value added. Colums (4)-(6) report results obtained when China and Argentina are dropped from the sample. 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 Technology Intensive Dummy is equal to one for ISIC codes 351, 352, 383, 384, and 385. The High FDI Dummy is equal to one in industries that 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 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 in the World Bank World Development Indicators. The Log of Real Exchange Rate is computed using nominal exchange rates taken from Heston, Summers, and Aten (2002) and measures of inflation from the IMF's 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)
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 * Technology 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 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)
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 Entry into Exports of New Goods

The dependent variable is the count of HS 10 digit product categories in which a reforming country exports to the U.S. for the first time in a given year. These data are available for the years 1989-2002; we limit the sample to 1989-1999 to ensure consistency with our other regressions. Data are taken from the trade data base documented in Feenstra, Romalis and Schott (2001). To prevent extremely small trade flows from biasing upward our counts of new export episodes, we drop export flows with extremely small (1-2) numbers of physical units. "Tech goods" restrict the sample to the set of 10-digit commodity categories which can be associated with ISIC codes 351, 352, 383, 384, and 385. Given the issues raised in the text about reforms in Argentina and China, columns (3), (4), (7) and (8) display results generated after removing these countries from the sample. 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 in a country. Host Country Inward FDI Restrictions and Host Country Capital Controls are dummy variables drawn from Brune (2004) and Schatz (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. Log of Real Exchange Rate is computed using nominal exchange rates taken from Heston, Summers, and Aten (2002) and measures of inflation from the IMFs 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	0.2120	0.2315	0.2030	0.2823	0.1530	0.2471	0.1481	0.2889
	(0.0121)	(0.0293)	(0.0140)	(0.0341)	(0.0596)	(0.0945)	(0.0675)	(0.1078)
Host Country Corporate Tax Rate	0.0616	0.1033	-0.0290	0.0968	-0.3055	-1.3105	-0.2415	-0.9800
	(0.0794)	(0.1914)	(0.0960)	(0.2311)	(0.3742)	(0.5540)	(0.4725)	(0.6814)
Host Country Inward FDI Restrictions	-0.0374	0.1710	-0.0010	0.1261	-0.1127	-0.0852	-0.1161	-0.1120
	(0.0245)	(0.0501)	(0.0261)	(0.0540)	(0.1216)	(0.1807)	(0.1275)	(0.1859)
Host Country Capital Controls	-0.1091	-0.1991	-0.0340	-0.0971	-0.1007	-0.0885	-0.1123	-0.1310
	(0.0197)	(0.0558)	(0.0226)	(0.0644)	(0.0839)	(0.1413)	(0.0995)	(0.1731)
Host Country Trade Openness	0.0123	0.0130	0.0131	0.0114	0.0060	0.0065	0.0087	0.0092
	(0.0008)	(0.0017)	(0.0008)	(0.0018)	(0.0034)	(0.0042)	(0.0038)	(0.0045)
Log of Host Country GDP per Capita	0.0935	-0.0256	-0.0920	0.2067	-0.0923	0.1427	-0.0155	0.3449
	(0.0417)	(0.0931)	(0.0567)	(0.1246)	(0.1582)	(0.2019)	(0.1912)	(0.2143)
Log of Real Exchange Rate	0.2477	0.2005	0.3130	0.1435	0.3162	0.1130	0.3449	0.1262
	(0.0263)	(0.0624)	(0.0302)	(0.0720)	(0.1300)	(0.1969)	(0.1541)	(0.2187)
No. of Obs.	178	178	156	156	178	178	156	156
Log Likelihood	-2452	-1194	-2274	-1096	-928	-703	-817	-618