Intellectual Property Rights as determinants of FDI, technology spillovers and R&D in developing economies*

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Abstract

The main channels of technology and knowledge acquisition for developing countries are FDI, imitation and domestic knowledge creation. However, policy measures to promote individual channels can be contradicting and interactions between channels render policy measures ineffective. This paper analyzes policy effects in light of these interrelations. The results show that the knowledge capital embodied in FDI supports the domestic R&D sector while impediments to FDI primarily hamper technology adoption in the South and fail as an instrument to promote domestic research by reduced competition from abroad. Stronger Intellectual Property Rights protection in developing countries leads to a transfer of R&D to emerging countries. However, the extension of FDI potentially crowds out domestic innovations.

Keywords: Intellectual Property Rights, Innovation, Foreign Direct Investments, Development

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1 Introduction

For developing countries, the acquisition of foreign knowledge and technologies from advanced economies and promotion of domestic R&D are essential for a successful transition from low-cost manufacturing economies to innovative industrialized countries. Foreign direct investments (FDI), domestic R&D, imitation and trade are the most prominent channels to achieve a higher technology level. As these channels are interrelated, however, their promotion can require conflicting policies. Imitation allows learning by copying existing technologies and raises employment in otherwise non-competitive economies (Glass, 2010; Helpman, 1993). At the same time, the risk of imitation deters foreign investors and leads to inefficient resource allocations (Gustafsson and Segerstrom, 2011; Glass and Saggi, 2002). FDI brings foreign expertise and technology into developing countries but also creates additional competition for domestic firms for market shares and local resources (Lall, 2002). Thus, the interdependence mechanisms between the channels of technology acquisition are crucial knowledge for the catch-up of transition countries. This paper analyzes the influence of Intellectual Property Rights (IPRs) and FDI policies on the attractiveness of developing countries for FDI, the acquisition of knowledge for domestic R&D and the availability of imitations.

The necessity for a joint analysis derives from the coexistence of imitation, FDI and R&D in developing countries that has emerged in recent decades. The OECD (2008a) reports an increasing share of world R&D hosted in developing countries. The distribution of Gross domestic expenditure on R&D (GERD) shifts towards non-OECD countries whose share in global R&D increased from less than 12% to over 18% from 1996 to 2005. A similar pattern arises for business R&D expenditures of profit-oriented enterprises. In China, South Africa, Russia and India, the ratios of R&D expenditure to GDP exceed those of high income countries like Greece and Portugal. For 2007, UIS (2009)\(^1\) reports that developing countries accounted for almost 24% of world GERD and employed approximately 38% of world researchers. Those R&D efforts result both from investments by domestic firms in developing countries as well as by foreign firms whose FDI expenditures are increasingly designated for R&D. The OECD (2008b) reports that

\(^1\)The UNESCO Institute for Statistics.
R&D expenditures of affiliates of US parent companies are increasingly spent in the Asia-Pacific region, rising from 4.6% in 1995 to 12% in 2005 (excluding Japan). For instance, after 0.1% in 1995 China attracts about 2.5% of US worldwide R&D FDI in 2005. In a survey in the United Nations World Investment Report 2005, China, India and Russia were reported among the top 10 most attractive R&D locations. The shares of foreign-funded R&D in total GERD for 2007 are still relatively low for China (1.3%) and Mexico (1.4%) but substantial for e.g. Russia (7.4%) and Eastern European countries\(^2\), exceeding 10% (UIS, 2011).

This paper uses a North-South structure of the world economy in which the North is at the frontier of technology. Agents in both regions can engage in innovation to develop new differentiated goods that are sold on monopolistic markets. To account for the increase in research-based FDI, northern investments in the South include the development of new products and their subsequent production. While FDI is attracted by differences in labor costs and a competitive advantage in R&D compared to southern firms, FDI goods are subject to imitation that results from insufficient IPR protection in the South. The benefits to the South from FDI include the transfer of knowledge capital, more efficient innovation and a higher demand for domestic labor. While the accumulation of knowledge promotes the domestic R&D sector, profits from FDI are transferred to the North. Imitation of FDI goods allows the competitive production in the South to the benefit of consumers and labor demand. However, the South is faced with the trade-off between low IPR protection and easy access to imitation, and higher IPR protection with more FDI incentives and faster knowledge accumulation. In addition to imitation, the costs for FDI firms to develop a new product variety and produce in the foreign market depend on the FDI policy of the South. Impediments may derive from restrictions on market access, requirements to enter joint ventures and bureaucratic costs.\(^3\) Those measures may be employed to protect domestic firms from competition by increasing the costs to enter the market for foreign firms.

The results show that higher IPR protection in the South strengthens FDI incentives and leads to an extension of research activity in the South. This reduces the knowledge gap and wage disadvantage to the developed region. The effect on domestic research depends on the FDI

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\(^2\)Ukraine, Slovakia, Latvia, Lithuania, Hungary, Estonia and Croatia.

\(^3\)As an example for additional FDI costs, The Economist (1999) recounts difficulties for foreign firms in China with local authorities, business partners and markets.
policy in the South: R&D by local firms increases only if impediments to FDI are sufficiently low. Otherwise, the South will not be able to acquire sufficient knowledge capital to withstand competition from FDI firms and is crowded out. Thus, impediments to foreign investments are no sensible policy instrument to promote domestic research. On the other hand, a reduction of impediments to FDI creates a knowledge inflow that raises R&D incentives in the South and its share in global innovation. This effect potentially outweighs additional FDI incentives such that R&D in the South increases at the expense of FDI.

The next section gives an overview over the relevant literature. It follows a description of the model and the balanced growth path. Comparative statics show the influence of intellectual property rights and impediments to FDI on southern participation in R&D, FDI and imitation. A numerical analysis looks at the impact on welfare.

2 Literature

The literature has mostly focused on individual channels of knowledge transfer to evaluate their importance for technology spillovers and the transition process. In the seminal paper Helpman (1993), imitation is the principle means for developing countries (the 'South') to gain access to technology developed in advanced economies (the 'North'). Given their lack of innovative capabilities, the South relies on imitation blueprints as a prerequisite for production. With stronger IPR protection, imitation and innovation decrease as northern labor is bound in production.4 Deardorff (1992) makes the case that a geographical limitation of IPR protection helps to reduce monopolistic distortions and improve technology access for developing countries.

The strict assignment of innovator and imitator roles to North and South has been extended to allow the study of interrelations. FDI is a means to transfer production from the North to the South which takes account of the comparative advantage of the North in innovation and the South in production. The South then faces a trade-off in its IPR policy between the

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4 In an extended version of the model with weak-scale effect and trade costs, Gustafsson and Segerstrom (2010) derive similar conclusions.
attractiveness for FDI and availability of imitations. From a theoretical point of view, Gustafsson and Segerstrom (2011) find that FDI is strictly promoted by better IPR protection as the risk of imitation decreases. The shift of production to the South allows the North to make use of its comparative advantage in innovation to increase global innovation. The same results are found by Lai (1998) who directly compares IPR effects when production transfer occurs by imitation of the North or FDI in a quality-ladder framework. On the other hand, Glass and Saggi (2002) point to the loss of resources in developing countries when IPRs are increased: more resources are drawn into a less efficient imitation process leading to increased factor prices. The resulting disincentive to FDI overcompensates the positive effect of a lower imitation rate and leads to fewer FDI. Glass and Saggi (1998) use a quality-ladder model in which imitation of low quality goods enables the South to gather the necessary stock of knowledge to attract high quality FDI. As imitation targets only low quality goods, no deterring effect occurs. On the contrary, high-quality FDI increases with imitation and frees resources for innovation in the North. These models assume that the South is recipient of FDI and imitator but does not engage in original R&D itself. This does not account for developing countries which make the transition to innovators and gives only limited insights into the role of knowledge spillovers embodied in FDI.

In empirical studies, the influence of intellectual property rights protection on the volume and composition of FDI has been found to be considerable. Lee and Mansfield (1996) find that IPRs have significant positive effects on both the volume as well as the composition of FDI in terms of its technology-intensity. Javorcik (2004) specifically analyzes the composition of FDI using firm-level data of Eastern European countries and confirms that lower IPR protection deters FDI especially from technology-intensive firms and leads to FDI that focuses on distribution rather than production of goods. A positive contribution of FDI on productivity in the receiving country has been shown, among others, by Borensztein et al. (1998) and Xu (2000). Both studies show that FDI promotes technology diffusion from developed to developing countries but that a certain level of development is necessary to absorb foreign technologies.

Another class of models attends to the spillover effect from imitation and its effect on southern innovative capabilities. Glass (2010) allows for innovation in the South where imitation functions as a prerequisite for innovation by providing the required knowledge base. She shows that
if imitation limits southern innovation, indiscriminate subsidies to imitation and innovation will increase southern and aggregate innovation and decrease the imitation rate. If imitation is not a restricting factor, the effect on innovation is unclear. Newiak (2011) analyzes the role of IPRs in the South when innovation is more efficient the more knowledge capital is appropriated via innovation and imitation. She finds that stronger IPR protection benefits the South only if the innovation sector is sufficiently large relative to imitation. Similarly, Lorenczik and Newiak (2011) show that stronger IPR protection can strengthen the southern innovation sector if it is sufficiently developed, generating higher innovation incentives and labor demand in the South. The model emphasizes the competition for R&D resources but does not consider learning effects from imitation. In Van Elkan (1996), the production efficiency benefits from independent knowledge creation (innovation) and adoption of foreign technologies (imitation). However, knowledge is non-rival which does not create a conflict of IPR protection between North and South.  

Empirical evidence on the growth effect of FDI is mixed. For Venezuelan firm-level data, Aitken and Harrison (1999) find a positive productivity effect for small enterprises while domestic firms experience negative spillovers from increased competition. Borensztein et al. (1998) emphasize the importance of developing countries’ absorption capabilities. Falvey et al. (2006) find positive growth effects of IPR protection for low and high income countries. For low income countries, FDI promotes growth but does not encourage domestic R&D or the (underdeveloped) imitation sector. In middle-income countries, a positive effect of stronger IPR protection on FDI is offset by a reduced imitation sector. Agosin and Machado (2005) note that the impact of FDI on domestic investments is ambiguous and may lead to a crowding out effect in developing countries.

5The implications are different in nature from the usual North-South conflict in that both countries would benefit from not being in the position of the technology leader/innovator.
3 Model

3.1 Basic structure

The world economy consists of two regions North and South of which the North is technologically advanced in its research capabilities. Representative households in both regions consume a variety of differentiated goods offered by firms in monopolistic competition on the world market. Labor is the only factor used in production and the development of blueprints for new varieties. It is mobile within all sectors of one region but immobile between regions, giving a single regional wage rate. New varieties are developed in the North and in the South. While the North has access to a larger knowledge capital which reduces the labor costs of developing a blueprint, the South uses a limited amount of world knowledge determined by spillovers and domestic research. The North can conduct innovative R&D domestically or via FDI in the South, in which case southern labor is hired for the blueprint development and subsequent production. However, innovations abroad are subject to an imitation risk as a result of imperfect IPR protection in the South. Once imitated, a variety is offered at marginal costs in an environment of perfect competition. Proceeds from non-imitated varieties go to the North. Thus, in contrast to other models, FDI comprises innovation and production in the South to account for the increasing share of R&D in FDI. Innovations in the North are not transferred to the South via FDI.\footnote{For models that analyze a shift of northern innovations to the South, see Gustafsson and Segerstrom (2011) and Glass and Saggi (2002, 1998)}

3.2 Households

Each region is inhabited by a fixed measure of households whose size grows exponentially at a constant rate $g_L$. Each member of a household is endowed with one unit of labor which is supplied inelastically to the labor market. Labor supply in North and South at time $t$ is given by $L^N_t = L^N_0 e^{g_L t}$ and $L^S_t = L^S_0 e^{g_L t}$, respectively. Households in the two regions are identical.
concerning their preferences and maximize the discounted lifetime flow of utility\footnote{The household problem does not indicate a specific region as it is identical for North and South. Superscripts are used to refer to a specific region where necessary. For brevity, time subjects are omitted whenever no risk of ambiguity arises.}

\[ U(t) = \int_t^\infty e^{-(\rho - g_L)t} \ln u(t) dt, \quad u(t) = \left[ \int_0^n x_{j,t}^\alpha dj \right]^{1\over \alpha} \]  

(1)

where \( \rho \) is the rate of time preference and \( g_L < \rho \). The utility at each point in time \( u(t) \) arises from consumption of a basket of \( n \) different varieties available on the world market; \( x_{j,t} \) is the per capita quantity demanded of variety \( j \), and \( \alpha \) is a measure of the degree of product differentiation with \( 0 < \alpha < 1 \), where smaller values of \( \alpha \) imply a higher product differentiation. It is related to the elasticity of substitution between varieties \( \sigma \) by \( \sigma = {1 \over 1 - \alpha} \). Households are constrained by their wage and asset income, giving rise to the budget constraint \( \dot{a} = ra + w - e - g_L a \). In this budget constraint, \( e_t \) indicates consumption expenditures, \( w \) represents the wage income and \( r \) is the interest rate paid on asset holdings \( a \) in the respective region. For the North, \( a^N \) is the value of shares from northern innovative firms and FDI firms. In the South, \( a^S \) contains shares of southern innovating firm. Solving the consumer’s maximization problem for North and South we obtain \( \bar{x}_{j,t} \), the average per capita demand for variety \( j \) by consumers in both regions at time \( t \),

\[ \bar{x}_{j,t} = \bar{e}_t \left( \bar{P}_{j,t} / \bar{P}_t \right)^{-\sigma}, \]  

where \( \bar{e}_t \) represents average consumption expenditures per consumer defined as \( \bar{e}_t = (e^N_t L^N_t + e^S_t L^S_t) / L_t \); \( p_{j,t} \) is the price of variety \( j \) and \( L_t = L^N_t + L^S_t \). The aggregate price index is defined as \( P_t = \left[ \int_0^n p_{j,t}^{1-\sigma} dj \right]^{1\over 1-\sigma} \). Let \( c_t \equiv e_t / P_t \) denote real consumption expenditures.

Following Dixit and Stiglitz (1977), this measure also represents consumers’ utility at time \( t \); we thus have \( c_t = u_t \). Solving the household problem shows that nominal expenditures grow at \( \bar{e}_t / \bar{e}_t = r_t - \rho \), and thus only increase over time if the market interest rate \( r_t \) exceeds the individual discount rate \( \rho \).

### 3.3 R&D and Imitation

Both regions have the ability to innovate new product varieties where the available knowledge capital and infrastructure determine the efficiency of the development process. The total number of varieties is denoted by \( n \) which is subdivided into innovations in the North, \( n^N_I \), FDI-financed
Innovations in the South, \( n^S_F \), of which \( n^S_C \) are imitated in the South, and original southern innovations \( n^S_R \), i.e. \( n = n^N_R + n^S_F + n^S_C + n^S_R \). Each variety is produced by an atomistic firm. The development of new varieties is modeled after Jones (1995). It requires labor input according to the following functions for northern innovations, FDI financed innovation in the South and southern innovations, respectively:

\[
\begin{align*}
\dot{n}^N_R &= \frac{n_0 \ell_R}{a_N} \\
\dot{n}^S_F + \dot{n}^S_C &= \frac{n_0 \ell_F}{a_S \phi} \\
\dot{n}^S_R &= \frac{n_0 \ell_R}{a_S} 
\end{align*}
\]

Innovators in both regions make use of the existing stock of knowledge embodied in the number of available varieties \( n \). The degree of knowledge spillovers from past R&D is determined by the parameter \( \theta < 1 \) which implies that knowledge spillovers become weaker over time and rules out strong scale effects. While the North can make use of knowledge originating in both regions, i.e. has perfect knowledge spillovers across regions, the South can only access domestically created knowledge capital while knowledge from northern innovations cannot be appropriated.\(^8\) \( k^S \) indicates the fraction of knowledge originating in the South and available to Southern innovators given by \( k^S = \frac{n^S_F + n^S_C}{n} \). This limitation does not affect FDI firms which make use of the whole set of knowledge.

\( a_N \) and \( a_S \) are region-specific R&D productivity parameters which capture differences in infrastructure and market environment rather than knowledge. For a given knowledge capital, they determine the labor costs for the R&D process from the innovation to the introduction of the product to the market that all atomistic firms face.\(^9\) \( \phi \) measures additional cost for FDI firms relative to domestic southerns innovators. It is larger than 1 where higher values indicate an unfavorable FDI policy deriving from bureaucratic burdens, specific regulations for foreign firms.

\(^8\)Similar notions of international knowledge spillovers are employed by Gustafsson and Segerstrom (2010) and Currie et al. (1999).

\(^9\)The World Bank (2011) accesses the market environment in terms of procedures, time and costs of starting a business, acquiring permits, legal issues etc. A result from the *Ranking on the ease of doing business* is that the strength of legal institutions is highest and the complexity and costs of regulatory processes are lowest in OECD and other high income countries and less favorable in other regions.
or frictions from an unfamiliar business environment.\textsuperscript{10} I assume that those factors are, to some extent, deliberately set by the South. The closer \( \phi \) is to 1, the fewer impediments to northern investments exist.

The risk of imitation for FDI firms is given by the imitation rate \( i = \frac{n^S}{n^F} \). It is thus defined as the probability that an FDI variety is imitated as a result of imperfect IPR protection at any moment in time. Alternatively, it can be regarded as the probability that a patent is not enforced by the South.\textsuperscript{11} If not enforced, the production blueprint is available to a large number of southern imitators and will be produced by a competitive fringe. The imitation rate is controlled by the South by the strength of IPR protection which functions as a policy instrument for the South to regulate the availability of imitated varieties and attractiveness of FDI. Imitation is exogenous for the market participants. The model abstracts from imitation of North-based and southern domestic innovations.

### 3.4 Investment into innovation

When making their investment decision, firms adjust instantaneous profits by the change in firm value, interest rate and risk of imitation to calculate the present discounted value of an innovation and compare this value to the blueprint costs. Let \( v^N_R \), \( v^S_F \) and \( v^S_R \) denote the firm values at time \( t \) for a northern innovation, FDI-blueprint and southern innovation, respectively. At the time of development, the blueprint costs have to equal the firm value under the assumption of free market entry. Investment into new varieties takes place until no excess profits can be generated.

The blueprint (i.e. development) costs for a new variety derive from the R&D functions (2) and

\textsuperscript{10}While some impediments to foreign firms may be unintended, imposed joint ventures or restricted access to some sectors deliberately favor local firms compared to FDI companies (Ianchovichina and Walmsley, 2003).

\textsuperscript{11}This notion of IPR protection is used in, among others, Grossman and Lai (2004) and Gustafsson and Segerström (2011). An equivalent approach is to regard \( i \) as the probability that the innovator cannot obtain an enforceable patent immediately after the variety is developed as in Eicher and García-Peña (2008).
are determined by the amount of labor needed times the wage rate. The costs are given by

\[ v^N_R = \frac{a_N w^N}{n^N} \]  \hspace{1cm} (3a)  
\[ v^S_F = \frac{a_S w^S}{n^S} \]  \hspace{1cm} (3b)  
\[ v^S_R = \frac{a_S w^S}{n^S k^S} \]  \hspace{1cm} (3c)

I assume perfect capital mobility within a region but financial autarky between North and South. Imitation risks can be fully diversified by holding the market portfolio such that firm assets bear no excess risks. No arbitrage between an investment in safe assets with return \( r \) and an investment in innovative firms ensures equal returns to both. For the North, the no-arbitrage condition is given by \( \frac{\pi^N_R}{v^N_R} + \frac{\dot{v}^N_R}{v^N_R} = r^N \), i.e. per period profits \( \pi^N_R \) relative to the firm value and the change in firm value have to equal \( r^N \). The condition for southern original R&D follows accordingly.

For FDI goods, additionally the risk of imitation has to be taken into account leading to the no-arbitrage condition \( \frac{\pi^S_F}{v^S_F} + \frac{\dot{v}^S_F}{v^S_F} - i = r^N \). From (3) follows a constant change in firm value of \( \dot{v} = -\theta g \), where \( g \equiv \frac{n}{n} \) is the growth rate of the total number of varieties. The no-arbitrage conditions give the appropriately discounted profits and can be written as

\[ v^N_R = \frac{\pi^N_R}{r^N + \theta g} \]  \hspace{1cm} (4a)  
\[ v^S_F = \frac{\pi^S_F}{r^N + \theta g + i} \]  \hspace{1cm} (4b)  
\[ v^S_R = \frac{\pi^S_R}{r^S + \theta g} \]  \hspace{1cm} (4c)

Both costs (3) and discounted profits (4) determine the relative number of varieties in equilibrium.

### 3.5 Production

Goods production requires one unit of labor for each output unit, i.e. for the production quantity \( \bar{x}_j \), \( \ell_{Y,j} = \bar{x}_j \) units of labor have to be employed. Monopolistic competition implies that firms set
prices with a mark-up over marginal costs determined by the degree of product differentiation \( \alpha \). The only exception are imitated goods that are priced at marginal costs. The prices for each variety are given by

\[
p^N_R = \frac{w_N}{\alpha}, \quad p^S_F = \frac{w_S}{\alpha} = p^S_R, \quad p^S_C = w_S
\]

The profit maximization problem of firms gives the instantaneous profits as

\[
\pi^N_R = \frac{1 - \alpha}{\alpha} w_N x^N_R L \\
\pi^S_F = \frac{1 - \alpha}{\alpha} w_S x^S_F L \\
\pi^S_R = \frac{1 - \alpha}{\alpha} w_S x^S_R L
\]

Instantaneous profits are generated indefinitely for northern and southern innovations. FDI profits cease when imitation occurs, at which point the blueprint becomes freely available for production by perfectly competitive firms in the South. This implies that imitators do not generate positive profits.

### 3.6 Labor markets

Finally, labor market clearing in North and South requires that the sum of workers employed in the R&D and production sectors equals the total labor force in each region. In the North, labor is allocated into R&D and production: \( L^N = \ell^N_R + \ell^N_Y \). In the South, labor is allocated into R&D funded by North and South and production of FDI, southern and imitated goods: \( L^S = \ell^S_R + \ell^S_F + \ell^S_Y \). Labor supply is inelastic and wages adjust to equalize labor demand and supply in both regions.
4 Balanced growth path

This section derives the steady-state equilibrium and analyzes the conditions that determine the equilibrium properties. The costs and benefits described in the previous section define the global innovation intensity and shares of each sector, the relative wage between the regions and the knowledge gap of the South.

4.1 Definition of the equilibrium and long-run growth

The equilibrium is given by a set of prices, wages and interest rates in North and South such that the allocation of labor into the different sectors, number of varieties and their supply, consumption expenditures and asset holdings solves the utility and profit maximization problems of households and firms and (2) labor, goods and financial markets clear given free market entry of firms. In this steady state equilibrium, variety growth $g \equiv \dot{n}/n$, the South-North wage ratio $\omega \equiv w^S/w^N$, the variety shares $\gamma_R^N \equiv n^N_R/n, \gamma_F^S \equiv n^S_F/n, \gamma_R^S \equiv n^S_R/n$ and $\gamma_C^S \equiv n^S_C/n$, and the shares of labor employed in the different sectors of each region are constant. Further, constant nominal consumption expenditures imply that the risk-free interest rates in North and South are equal to the rate of time preference $\rho = r^N = r^S$.

As the variety shares are constant in steady state, the number of varieties in each category has to grow at the same rate $g = \dot{n}/n = \dot{n}_R^N/n_R^N = \dot{n}_F^S/n_F^S = \dot{n}_R^S/n_R^S = \dot{n}_C^S/n_C^S$. Dividing (2a) by $n$ and using the fact that the R&D employment ratio $\ell_R^N/L^N$ is constant in steady state, the equilibrium growth rate is determined as

$$g = \frac{g_L}{1 - \theta}$$

(7)

The growth rate is finite and positive for $\theta < 1$. However, it is independent of policy parameters. This semi-endogenous growth implies that policy actions do not have any effect on the long-run growth rate but the transition only.
4.2 Equilibrium in R&D and product markets

Free entry drives profits from monopolistic competition, (4), down to equal the costs of innovations (3). This results in the following steady-state cost-benefit conditions

\[ \frac{a_N}{n^\theta} = \frac{1-\alpha x^N L}{\rho + \theta g} \]  

(8a)

\[ \frac{a_S \phi}{n^\theta} = \frac{1-\alpha x^S L}{\rho + \theta g + i} \]  

(8b)

\[ \frac{a_S}{n^\theta k^S} = \frac{1-\alpha x^S R L}{\rho + \theta g} \]  

(8c)

All cost-benefit conditions have to be satisfied in an equilibrium in which innovation in the North, FDI and innovation by southern firms coexist. By dividing the cost-benefit conditions (8) by each other and using the relative demand quantity

\[ \bar{x}^i_j = \left( \frac{p_i}{p_j} \right)^{-\sigma}, \]

the equilibrium values of the relative wage \( \frac{w^S}{w^N} \) and fraction of global innovation originating in the South, \( k^S \), can be determined:

\[ \left( \frac{w^S}{w^N} \right)^\sigma = \frac{a_N}{a_S \phi} \frac{\rho + \theta g}{\rho + \theta g + i} \]  

(9a)

\[ k^S = \frac{1}{\phi} \frac{\rho + \theta g}{\rho + \theta g + i} \]  

(9b)

Equation (9a) gives the relative wage necessary to ensure equal return profiles for innovation in the North and FDI. In other words, this relation has to hold to satisfy (8a) and (8b) simultaneously. Otherwise, investors in the North would prefer one sector over the other. The profitability of innovation in the North is determined by the research efficiency \( a_N \). The profitability of FDI depends on the research efficiency \( a_S \phi \) and the imitation rate \( i \). The North will only engage in both activities if the location disadvantage deriving from the risk of imitation and the efficiency difference is offset by a sufficient wage gap to the South. The wage gap decreases with higher IPR protection and a reduction of impediments to FDI.

Similarly, relation (9b) ensures that the cost-benefit conditions for FDI (8b) and innovation by southern firms (8c) hold simultaneously. Otherwise, FDI drives out southern innovation or vice versa. With higher impediments to FDI \( \phi \) and imitation risk \( i \), FDI becomes less profitable.
compared to domestic innovation and can only compete if the knowledge advantage is sufficiently large, i.e. $k^S$ is small. On the other hand, low $\phi$ and $i$ require a high relative knowledge of the South to avoid a crowding out by FDI firms.\footnote{The conditions have to be satisfied in equilibrium. However, $i$ and $\phi$ have to be compatible with labor-market clearing such that the South cannot simply set $i = 0$ and $\phi = 1$ to achieve high relative wages and knowledge capital.}

From the definition of $k^S = \frac{n^S_R + n^S_F + n^S_C}{n} = \gamma^S_R + \gamma^S_F + \gamma^S_C = 1 - \gamma^N_R$ and (9b) follows the equilibrium share of northern innovations in all varieties

$$\gamma^N_R = 1 - \frac{1}{\phi} \frac{\rho + \theta g}{\rho g + i}$$ \hspace{1cm} (10)

The equation implies that the concentration of global innovation in the North is high when incentives to invest in FDI are low (high $i$ or $\phi$). Whenever the South increases its attractiveness for foreign investments, its share in innovation increases.

### 4.3 Labor market equilibrium

Given the equilibrium conditions for R&D and product markets, the model can be solved by solving for the labor market equilibria in North and South. To this end, equilibrium values are substituted into the labor market clearing conditions in section 3.6. This results in two steady-state conditions in two unknowns, the research intensity $\delta$ and the share of domestic southern innovations in global R&D, $\gamma^S_R$. $\delta \equiv \frac{n^S_R}{n^S_R + n^S_F + n^S_C}$ is a measure for the extent of research conducted relative to the size of the northern labor force. The term is coined relative research difficulty in Gustafsson and Segerstrom (2011) as a high $\delta$ implies a high global level of R&D and a small market share for each innovation. It is constant in steady state. The equilibrium is found at the intersection of the two steady-state conditions in the $\delta-\gamma^S_R$–plane.

For the North, the labor market clearing condition from section 3.6 is combined with (2a), (8a) and the equilibrium value of $\gamma^N_R$ to get the northern steady-state condition

$$1 = \delta a_N \left[ 1 - \frac{1}{\phi} \frac{\rho + \theta g}{\rho g + i} \right] \Delta$$ \hspace{1cm} (11)
where $\Delta = g + \frac{\alpha}{1-\alpha} (\rho + \theta g)$ is constant. The condition shows that labor market clearing depends on the research efficiency in the North $a_N$, the share of global innovations based in the North $g_R$ and a constant of demand and preference parameters $\Delta$. The condition is invariant to whether R&D in the South is conducted by FDI or domestic firms and therefore vertical in the $\delta - \gamma_S^R$-plane.

As $\delta$ is the only variable, it determines the global equilibrium number of varieties. The share of northern labor allocated to innovation derives from (2a), (10), (11) and the definition of $\delta$, which gives $\ell^N = \frac{g}{\Delta} L^N$, i.e. a constant fraction of northern labor is used for innovation with the residual devoted to production, independent of the FDI policy or imitation rate in the South. This equation shows the interdependence of FDI and southern R&D that share the market for innovations originating in the South. The division is influenced by model parameters and incentives to invest in FDI, namely $i$ and $\phi$. Changes in these parameters change the relative size of $\gamma^S_F$ and $\gamma^S_R$ as well as their combined share.

Substituting the demand for FDI products and southern innovations from (8b,c), the labor costs of innovation from (2b,c) and the variety shares into the southern labor market clearing condition gives the southern steady-state condition

$$1 = \delta \frac{L^N}{L^S} a_S \left( -\gamma^S_R \phi \Lambda_S(i) + \Lambda_I(i) \right) \quad (12)$$

where $\Lambda_S(i)$ and $\Lambda_I(i)$ are positive functions of the imitation rate $i$. The negative factor on $\gamma^S_R$ implies that the South supports a higher global number of varieties with a higher domestic research share; this is due to efficiency gains from existing innovations. The southern labor

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13Production labor is given by $\ell^N = \frac{\Delta - g}{\Delta} L^N$.

14The slope constant is given by $\Lambda_S(i) \equiv i \left[ \frac{g}{\rho + \theta g} \right]^{(\alpha-\sigma-1)} - \frac{\alpha}{1-\alpha} \frac{\alpha}{1-\alpha} > 0$ with $\frac{\partial \Lambda_S}{\partial i} > 0$, and the intercept by $\Lambda_I(i) \equiv (\rho + \theta g) \left[ \frac{g}{\rho + \theta g} + \frac{\alpha}{g} \right] > 0$ with $\frac{\partial \Lambda_I}{\partial i} > 0$. The signs are determined using $\rho + \theta g > g$ from the household problem and $\frac{\alpha}{g(\alpha-\sigma-1)} > 0$. The last inequality is satisfied if the share of global innovations based in the South $g_R$ is less than one.
market clearing condition is thus upward sloping in the $\delta - \gamma^S_R$-plane. It has a positive $\delta$-intercept $L^S(L^N a_N \Lambda_I)^{-1}$. The equilibrium on the labor market is given by the intersection of both steady-state conditions which determines the research intensity $\delta$ and the share of southern domestic varieties $\gamma^S_R$ as shown in figure 1. In the following, I assume that the equilibrium exists and satisfies $0 \leq \gamma^S_F, \gamma^S_R < 1$.\footnote{See section 5.3 for details.}

4.4 Welfare

To make welfare predictions of policy changes, I solve for asset holdings, consumer expenditures and the economic growth rate. The aggregate value of northern assets $A^N$ is the product of the number of northern innovations and non-copied FDI goods and their respective value, i.e. $A^N = n^N_R v^N_R + n^S_R v^S_R$. Substituting by (3) yields $A^N = \left( \gamma^N_R a_N w^N + \gamma^S_R a_S w^S \right)n^{1-\theta}$. The southern aggregate asset value $A^S$ consists of southern innovating firms, so that it is given by $A^S = n^S_R v^S_R = \gamma^S_R a_S w^S \phi^{2+\theta}}{\phi^2+\theta} - \theta$. It follows that per capita asset holdings in the North $a^N = A^N/L^N$ and the South $a^S = A^S/L^S$ are constant in equilibrium. With the budget constraint of the representative household, $e = (r - g_L)a + w$, the per capita consumption expenditure levels $e^N$ and $e^S$ are determined as functions of the variety shares, wage rates
and total number of varieties. Using the variety shares, the aggregate price level is given by
\[ P_t = n_t^{1/(1-\sigma)} \left\{ \gamma_N(p_N^R)^{1-\sigma} + \gamma_F(p_F^R)^{1-\sigma} + \gamma_S(p_S^R)^{1-\sigma} + \gamma_C(p_C^R)^{1-\sigma} \right\}^{1/(1-\sigma)}, \]
which decreases over time with the extent of available varieties.

With constant nominal per capita consumption expenditure \( e \) and a decreasing aggregate price level \( P_t \), utility grows over time. Utility growth can be interpreted as real consumption growth or economic growth. Real consumption growth in this model is given by \( \frac{\dot{u}}{u} = \frac{\dot{c}}{c} = \frac{g}{\sigma - 1} \equiv g_e > 0 \). As the steady state growth rate of real consumption in both regions is equal and independent of the policy parameters, a long-run welfare analysis of changes in parameter values can be simplified to the analysis of changes in \( c_{N0}^c \) and \( c_{S0}^c \).

5 Comparative statics

The role of FDI in the development of the southern R&D sector depends on the imitation risk \( i \) which represents the strength of IPR protection for foreign firms in the South. The second factor is the difficulty for FDI firms to innovate in the South relative to local southern firms, expressed by the FDI policy parameter \( \phi \). The following sections discuss changes in these parameters on the southern innovation behavior and the global level of research represented by changes of the steady-stage conditions (11) and (12).

5.1 IPR protection

An increase in IPR protection in the South is represented by a decrease in the imitation rate \( i \). From (9) follows an increase in the relative wage of the South and a reduction of the knowledge gap to the North. The variety share of northern innovations, \( \gamma_N^R \), reduces according to (10). The changes in the steady-state conditions are depicted in figure 2. The northern condition shifts to the right: while the North develops a smaller share of global varieties, it does not change its innovation labor and can thus support a higher global level of R&D. As FDI becomes

16This approach has been taken by Gustafsson and Segerstrom (2011). Welfare changes along the transition path are not possible with this approach and beyond the scope of this paper.
more attractive, the North funds more innovations in the South until equal return profiles for innovations in North and FDI are restored.\textsuperscript{17}

![Figure 2: Equilibrium in the $\delta-\gamma_R^S$-plane for $i \downarrow$.](image)

For the southern steady-state condition, the $\delta$ intercept increases and the curve rotates counterclockwise. The complete effect derives from lower demand with higher southern wages, changes of the extent to which global R&D is conducted in the South and the (change of the) composition of southern varieties, in particular FDI and imitation goods. More specifically, a higher relative wage in the South reduces the demand for southern varieties of all types as their price increases relative to the overall price level. This lowers the demand for southern production labor (demand effect). Additionally, with a lower imitation rate $i$, there are less imitated FDI goods which, priced at marginal costs, have a higher production quantity than monopolistic FDI varieties. Therefore, for a given investment by the North, more non-imitated FDI varieties remain which require less production labor (composition effect). This effect is limited to FDI goods and thus stronger the higher the share of FDI in innovation in the South. On the other hand, the South bears a higher share in global R&D in the low $i$ regime, i.e. for the same $\delta$, more products will be developed and produced in the South, requiring more research labor (innovation share effect). The demand effect together with the composition effect allow the South to support more global varieties while the innovation share effect reduces the support for $\delta$. Which

\textsuperscript{17}As I assume perfect capital markets, firms are not financially constraint and can always invest in profitable innovations.
effects dominate depends on the share of original southern R&D, $\gamma^S_R$. For a low level of $\gamma^S_R$, the composition effect of FDI goods is large such that, together with the demand effect, it outweighs the innovation share effect and allows the South to support a higher global number of varieties (higher $\delta$-intercept). For high $\gamma^S_R$, the composition effect is small and the innovation share effect dominates which reduces the number of global varieties the South can support (counterclockwise rotation).

The overall effect of stronger IPR protection on the share of southern innovations in the new equilibrium is not apparent and requires a direct analysis of $\gamma^S_R$. As (11) fully determines $\delta$, it is used to substitute for $\delta$ in (12) to derive a formula in which $\gamma^S_R$ is determined by model parameters only. It can be shown that the effect of higher IPR protection on $\gamma^S_R$ in equilibrium depends on the strength of impediments to FDI $\phi$. For low $\phi$ up to a threshold level $\bar{\phi}$, $\gamma^S_R$ will increase. Above the threshold $\bar{\phi}$, the change in incentives is so large that $\gamma^S_R$ decreases as $\gamma^F_R$ absorbs more than the gain in global innovation share of the South. This results from a higher incentive gain for FDI firms than for southern R&D when $\phi$ is high as the gains in knowledge capital and wage for the South will be small. Proposition 1 summarizes the effects.

**Proposition 1** When IPR protection for FDI goods is improved ($i$ ↓), the relative southern wage $w^S/w^N$ and global innovation intensity $\delta$ increase and the innovation share of the North $\gamma^N_R$ decreases. This raises the southern relative knowledge capital $k^S$ and increases the share of global innovations developed in the South. The shares of FDI, imitation and southern innovation change depending on the relative gain in profitability: If impediments to FDI are below the threshold level $\bar{\phi}$, the wage and knowledge increases are sufficient to support a higher $\gamma^S_R$. If $\phi > \bar{\phi}$, $\gamma^S_R$ falls and FDI expands by more than the additional innovation share of the South.

### 5.2 FDI policy

FDI impediments $\phi$ determine the innovation costs for FDI firms above the efficiency parameter for the South $a_S$. These costs can derive from additional bureaucratic and legal obstacles for

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18 The exact threshold level of $\bar{\phi}$ depends on the parameters of the model. It can be shown that it lies above $\phi = 1$, i.e. if there are no impediments to FDI, southern research will always gain from higher IPR protection. Details are available from the author upon request.
foreign firms in the South and additional initial setup costs for a production plant or distribution network due to the unfamiliar business environment. When the South adopts a more FDI-friendly policy ($\phi \downarrow$), initial development costs decrease (FDI cost effect) which makes investments more attractive for the North and shifts the global innovation share to the South.  

As more innovations originate in the South, the knowledge gap decreases which entails higher relative wages for the South. Its lower share in global innovation shifts the northern steady-state condition outwards. For the South, a lower $\phi$ implies that the steady-state condition rotates to the left around the $\delta$ intercept: With a higher share in global innovation, more southern labor is used in the R&D sectors for any research intensity $\delta$ (innovation share effect). If all innovation in the South is in the form of FDI, the same number of global varieties as before can be supported. This is because the change in $\gamma_F^S$ is proportionate to the change in $\phi$ and just sufficient such that the innovation share effect, demand effect and FDI cost effect cancel out. This leaves the $\delta$-intercept unchanged.  

With a positive southern innovation share $\gamma^S_R$, the South supports a lower number of global varieties as the increase in efficiency in innovation is not sufficient to account for the higher innovation share of the South which causes the rotation. In the new equilibrium, fewer FDI impediments increase the innovation share of southern domestic innovations $\gamma^S_R$. The overall effect on FDI is ambiguous: While lower initial costs increase FDI incentives, higher southern wages decrease the profitability of FDI and higher relative knowledge capital of the South increases competition by southern innovators. Depending on the relative strength, the expansion of southern innovation potentially outweighs FDI incentives such that FDI is crowded out. The equation for the relative knowledge in the South, (9b), shows that the effect on $k^S$ is stronger for small $\phi$ and small $i$, i.e. FDI is more likely to decrease with lower FDI impediments when FDI incentives are already relatively strong. The equilibrium effects are shown in figure 3 and proposition 2 summarizes the effects.

**Proposition 2** A reduction of impediments to FDI ($\phi \downarrow$) results in an increase of the relative southern wage $w^S/w^N$ and share of global innovations developed in the South \((\gamma^N_R + \gamma^S_C + \gamma^S_R) \uparrow\)

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$^{19}$Innovation in the North remains constant while innovation in the South expands such that relatively more innovations are developed in the South.

$^{20}$This can be seen from the southern labor market clearing condition (12) which is independent of $\phi$ when $\gamma^S_R = 0$. Thus, the $\delta$-intercept does not change with $\phi$. 

20
which raises the southern relative knowledge capital $k^S$. In the new equilibrium, the share of domestic innovations in the South, $\gamma^S_R$, and the research intensity, $\delta$, increase unambiguously. If the policy change happens in an already FDI-friendly environment, the FDI share $\gamma^S_F$ can potentially fall due to stronger local competition and the reduced wage difference.

5.3 Equilibria without FDI or southern R&D

The previous analysis deals with interior solutions for which the model parameters and policy variables ensure that the steady-state conditions intersect in the $\delta-\gamma^S_R$-plane and $0 \leq \gamma^S_F, \gamma^S_R < 1$. No equilibrium including all sectors exists when (a) the northern steady-state condition lies to the left of the $\delta$-intercept of the southern condition or (b) the intersection lies so far to the right that the cost-benefit conditions (8) are not satisfied for positive variety shares for each sector, i.e. not all sectors attain equal profitability. (a) represents the case in which the innovation share of the North is very high with few innovations developed in the South. At the research intensity $\delta$ supported by the North, the southern labor market does not clear as it requires a larger number of varieties developed and produced in the South. For (b), the South develops a large share of global innovations, its relative knowledge capital and relative wage are high. The strong innovation incentives for the South crowd out FDI to violate $\gamma^S_F \geq 0$. The paper only
Proposition 3 An equilibrium which exhibits northern R&D, FDI and southern-funded innovation does not exist if (a) innovation is too low in the South to achieve a labor market equilibrium or (b) the southern relative knowledge and wage are too high such that the non-negativity condition of FDI is violated. Otherwise, a unique equilibrium exists in which costs and benefits of all activities balance, each sector has a positive share in total variety production and labor markets clear.

5.4 Numerical analysis

The numerical analysis of the model gives insights into the effects of policy changes on long-run welfare. Additionally, changes of the FDI activity cannot be fully determined analytically and are presented here.

5.4.1 Calibration of the model

To calibrate the model, parameters are set to match the following target moments:\(^21\) The real interest rate takes a value of 7% according to the average real US stock market return over the past century estimated by Mehra and Prescott (1985). This implies a subjective discount rate \(\rho\) of the same value. Basu (1996) and Norrbin (1993) estimate a markup of 40% over marginal costs, determining the degree of differentiation between varieties \(\alpha\) to be 0.714. The population growth rate \(g_L = 1.68\%\) represents the average annual world population growth rate between 1960-2008 reported by the World Bank World Development Indicators 2009 (World Bank, 2009). Only the ratio of population sizes, \(L^S/L^N\), is relevant for the steady state equilibrium. The ratio of population in low and middle to high income countries is about 5.27 for 2008 figures (World Bank, 2009) such that \(L^S/L^N = 5.27\). To achieve a utility growth rate \(g_c\) of about 2%, reflecting the average US GDP per capita growth rate from 1950-1994 as reported in Jones (2005), I set the

\(^21\)For the sake of comparability, the target moments are calibrated as in Gustafsson and Segerstrom (2011) and Lorenczik and Newiak (2011) where applicable.
value of intertemporal R&D spillovers to $\theta = 0.67$. For the research difficulty, the North is the efficiency benchmark with $a_N = 1$. The southern infrastructure disadvantage is set to $a_S = 2.5$. Impediments to FDI are set to $\phi = 2$ which halves the research efficiency for FDI compared to southern innovators (before knowledge differences). The imitation rate $i$ is set to 10%. Wage in the North $w^N$ is set to unity such that $w^S$ gives the southern relative wage.

5.4.2 Change of IPR protection

The first simulation shows the effects of higher IPR protection in the South which reduces the imitation rate from 10% to 5%. In table 1, the first column contains the benchmark case with $i = 0.1$ and $\phi = 2$. Approximately $3/4$ of global innovations are developed in the North, with the residual quarter coming in about equal parts from southern innovation and FDI. Due to the relatively high imitation rate, $2/3$ of all FDI innovations are imitated. The South is considerably behind in available knowledge capital with about one quarter of the knowledge available to the North. In an FDI friendly environment ($\phi = 2$), the effects are as expected: overall innovation increases with $\delta$, the South achieves a higher global research share, knowledge capital and relative wage for the South increase. This increases innovation incentives and reduces demand for production labor to increase both domestic innovation and FDI. More efficient innovation and the extension of available varieties outweigh the reduced access to imitated varieties to raise per capita utility in both regions. The effects for the case of high FDI impediments ($\phi = 4$) are similar. However, changes in relative knowledge, wage and global innovation shares are smaller and the inflow of FDI supplants domestic innovation in the South (case of $\phi > \hat{\phi}$). Both regions gain from the policy change although the South falls short of the utility achieved in the FDI friendly environment.

Numerical Result 1 With stronger IPR protection ($i \downarrow$), the expansion of total varieties and higher efficiency in innovation outweigh utility losses from the reduced access to imitated varieties such that utility in both regions increases. The FDI share in global innovation goes up independently of FDI impediments. In an FDI-friendly regime, the share of domestic innovation
Table 1: Stronger in IPR protection (i ↓)

<table>
<thead>
<tr>
<th>FDI impediments</th>
<th>( \phi = 2 )</th>
<th>( \phi = 4 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imitation rate i</td>
<td>0.1 0.05</td>
<td>0.1 0.05</td>
</tr>
<tr>
<td>R&amp;D intensity ( \delta )</td>
<td>4.319 4.858</td>
<td>3.688 3.871</td>
</tr>
<tr>
<td>Innovation share N ( \gamma_N )</td>
<td>0.745 0.662</td>
<td>0.872 0.831</td>
</tr>
<tr>
<td>Innovation share S ( \gamma_S )</td>
<td>0.130 0.185</td>
<td>0.036 0.024</td>
</tr>
<tr>
<td>FDI share ( \gamma_F )</td>
<td>0.042 0.077</td>
<td>0.031 0.073</td>
</tr>
<tr>
<td>Imitation share ( \gamma_C )</td>
<td>0.083 0.075</td>
<td>0.061 0.072</td>
</tr>
<tr>
<td>Rel. knowledge capital S ( k )</td>
<td>0.255 0.338</td>
<td>0.128 0.169</td>
</tr>
<tr>
<td>Relative wage ( w^S/w^N )</td>
<td>0.521 0.564</td>
<td>0.427 0.463</td>
</tr>
<tr>
<td>Utility (p.c.) N ( u^N )</td>
<td>1.181 1.194</td>
<td>1.182 1.199</td>
</tr>
<tr>
<td>Utility (p.c.) S ( u^S )</td>
<td>0.550 0.602</td>
<td>0.438 0.469</td>
</tr>
</tbody>
</table>

In the South increases. With high FDI impediments, FDI increases at the expense of domestic innovation and utility for the South is lower.

5.4.3 Change of FDI policy

The simulation in table 2 shows the effects of changes of FDI impediments from a high level \( (\phi = 4) \) to no impediments \( (\phi = 1) \).\(^{22}\) Reductions of impediments to FDI increase the global innovation output \( (\delta \uparrow) \) with rising variety shares of the southern region. Both relative knowledge and wage increase steadily. Despite more favorable FDI policies, FDI investments, i.e. \( \gamma^S_F \), increase only moderately as domestic innovation in the South, with a diminishing knowledge disadvantage and increasing wage, becomes more competitive. For very low \( \phi \), FDI even decreases. The simulation shows that FDI impediments as a means to foster domestic innovation by removing competition from FDI firms is counterproductive as it suppresses the development of a competitive local innovation sector. Only with lower FDI impediments global innovation shifts to the South and the knowledge gap can be reduced. The gap in utility also decreases with lower FDI impediments: While the North compensates the reduction in available varieties with low-priced southern imitations to maintain a steady utility level (even a slight increase) in an FDI-unfriendly regime, the South benefits strongly in utility from lower FDI impediments.

\(^{22}\)The case of no FDI impediments might not be feasible as FDI firms face certain costs from the unfamiliar business environment but provides an interesting reference point.
**Numerical Result 2** With lower impediments to FDI ($\phi \downarrow$), global innovation, southern relative wage and knowledge increase. Innovation in the South becomes more competitive and steadily increases while the variety share of FDI, $\gamma_S^F$, increases moderately and falls close to $\phi = 1$. Southern utility benefits strongly from the removal of FDI impediments while the North experiences a slight reduction in utility caused by the deterioration of its terms of trade and access to imitation.

<table>
<thead>
<tr>
<th>FDI policy</th>
<th>$\phi$</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D intensity</td>
<td>$\delta$</td>
<td>3.688</td>
<td>3.876</td>
<td>4.319</td>
<td>6.567</td>
</tr>
<tr>
<td>Innovation share N</td>
<td>$\gamma_N^R$</td>
<td>0.872</td>
<td>0.830</td>
<td>0.745</td>
<td>0.490</td>
</tr>
<tr>
<td>Innovation share S</td>
<td>$\gamma_S^R$</td>
<td>0.036</td>
<td>0.061</td>
<td>0.130</td>
<td>0.496</td>
</tr>
<tr>
<td>FDI share</td>
<td>$\gamma_S^F$</td>
<td>0.031</td>
<td>0.037</td>
<td>0.042</td>
<td>0.005</td>
</tr>
<tr>
<td>Imitation share</td>
<td>$\gamma_S^C$</td>
<td>0.061</td>
<td>0.072</td>
<td>0.083</td>
<td>0.010</td>
</tr>
<tr>
<td>Rel. knowledge capital S</td>
<td>$k_S^S$</td>
<td>0.128</td>
<td>0.170</td>
<td>0.255</td>
<td>0.510</td>
</tr>
<tr>
<td>Relative wage</td>
<td>$w_S^S/w_N^N$</td>
<td>0.427</td>
<td>0.464</td>
<td>0.521</td>
<td>0.635</td>
</tr>
<tr>
<td>Utility (p.c.) N</td>
<td>$u_N^N$</td>
<td>1.182</td>
<td>1.182</td>
<td>1.181</td>
<td>1.172</td>
</tr>
<tr>
<td>Utility (p.c.) S</td>
<td>$u_S^S$</td>
<td>0.438</td>
<td>0.480</td>
<td>0.550</td>
<td>0.737</td>
</tr>
</tbody>
</table>

### 5.5 Discussion

In the classic North-South model, the South relies completely on imitation and stronger IPR protection reduces the availability of production blueprints for the South and access to low-priced imitated goods for both regions without improving innovation incentives. The introduction of FDI allows for an economic incentive to introduce stronger IPRs in the South to attract FDI. Gustafsson and Segerstrom (2011) show that the costs of stronger IPRs, i.e. lower imitation, are outweighed by the transfer of production via FDI. This result relies on a strong incentive effect from increased IPR protecting which ensures increased demand for domestic labor in the South. However, for transition economies, the effects on the southern ability to innovate are as important as its attractiveness for FDI. The additional knowledge transfer embodied in FDI shows that the South can further benefit from FDI as its R&D ability improves with higher research investments in the developing country. Nevertheless, the effect on domestic innovation
in the South is ambiguous as FDI firms compete with local innovators, a dimension absent in models without southern innovation. While competition from FDI potentially crowds out domestic innovation, the analysis shows that the costs of protective policy making in the South are high: Although the South can promote domestic research by high impediments to FDI and loose IPR protection, it will do so at a low and inefficient level of domestic R&D. At the same time, welfare costs in terms of long-run utility are high. On the other hand, with spillovers from a liberal FDI sector southern research can much rather gain in efficiency to reduce the dependence on FDI and imitation as the knowledge and wage gaps to the developed North diminish. Southern long-run welfare also benefits from favorable FDI policies: More efficient innovation extends the range of available product varieties and outweighs utility losses from reduced access to imitation goods. The benefits from imitation prove to be much stronger for the North that slightly loses utility when faced with an emancipated South.

6 Concluding Remarks

The analysis of changes of the balanced growth path for different policy regimes shows the complex interaction of foreign direct investments, imitation and southern innovation. Policy makers in the South have to take into account side-effects of intellectual property rights and FDI impediments on all activities in the South to evaluate their appropriateness for the pursued development goals. Higher IPR protection attracts more foreign direct investments which have a higher efficiency in innovation than local firms. As more research in carried out in the South, its knowledge capital disadvantage is eased and the wage gap to the North reduces. The effect on domestic innovation in the South is ambiguous: only when FDI impediments are small sufficient knowledge capital can be accumulated to face competition from FDI. This shows that impediments to FDI are not suitable to support domestic innovation in the South as innovators are deprived from the access to knowledge capital which is essential for their competitiveness.

While the model allows a comprehensive analysis of the interdependencies of IPRs, FDI, imitation and innovation, there are some caveats to the approach. The formulation of the southern
knowledge capital does not allow to distinguish between knowledge contributions from FDI and innovation. Impediments to FDI may be more justified if knowledge does not fully dissipate into the South when innovation is under the surveillance of the North. Additionally, the model does not allow for production transfers of northern innovations. This accounts for the increased R&D share in FDI but narrows the notion of foreign investments. These issues are left for future research. Nevertheless, the current model allows some insights into the importance of IPR protection for the development of a competitive innovation sector in emerging countries.
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