Three Essays on The Role of Intellectual Property Rights in Innovation, Foreign Direct Investments and Imitation

Inaugural-Dissertation
zur Erlangung des Grades
Doctor oeconomiae publicae (Dr. oec. publ.)
an der Ludwig-Maximilians-Universität München
Volkswirtschaftliche Fakultät

2011

vorgelegt von

Christian Lorenczik

Referent: Prof. Theo Eicher, PhD
Korreferent: Prof. Matthias Doepke, PhD
Promotionsabschlussberatung: 16. Mai 2012

Datum der mündlichen Prüfung: 30. Mai 2012
Namen der Berichterstatter: Theo Eicher, Matthias Doepke, Gerhard Illing

Für meine Eltern

Acknowledgements

In writing my thesis, I received invaluable support from numerous people without whom this project would have turned out completely different. First and foremost, I would like to thank Theo Eicher who had the largest impact on the course of my PhD. His inspiring lectures, contagious enthusiasm for development economics, our insightful discussions, his continuous encouragement and jolly character wakened my research interests and gave me the confidence to try my luck in academia. His advice in Munich, over the phone, by e-mail and during my visit to the University of Washington in Seattle helped to improve my thesis in every aspect.

Furthermore, I would like to thank my co-author and friend Monique Newiak for the fruitful collaborations, her patience and companionship. As in all graduate schools, economics at the LMU has its virtues and shortcomings. Luckily, the department offers opportunities to ameliorate its shortcomings. In particular, I thank the affiliate professors Matthias Doepke, Michèle Tertilt, Monika Piazzesi, Martin Schneider and Theo Eicher for hosting the brown bag seminar, their insightful comments and suggestions, and the academic spirit they created. Further, I would like to thank Matthias Doepke for acting as my second advisor and his support for my endeavors on the job market. Further, I am grateful for the hospitality I experienced from Gerhard Illing and his seminar for macroeconomics. I also thank Gerhard Illing for acting as examiner for my defense.

My colleagues and friends in Munich made my PhD experience much more valuable beyond classes and research. I am thankful to all of them. During my research and writing, I made use of a range of open source software developed by innumerable contributors. I like to thank those enthusiasts for LaTeX, R, GNU Octave, Ubuntu/Linux and various other software packages. Finally, I thank my parents and my brother Stefan for constant support and encouragement.

Christian Lorenczik, June 2012

Contents

List of Tables

List of Figures

Preface

Ever since Paul Romer's theory of *Endogenous technological change*, economic growth has been closely associated with innovation and research to increase technological knowledge, improve production processes and extend the range of available products. Innovation enables perpetual economic growth as it yields private returns to innovators and public returns to the economy. Private returns are variety blueprints or production technologies that give innovators an advantage over competitors and allow them to reap positive profits. The public return is non-rival knowledge that becomes available to other members of the economy and facilitates future innovations. To sustain growth, appropriate intellectual property rights (IPR) institutions have to be established to protect private incentives to innovate. What is appropriate, however, depends on the perspective of individual countries and policy makers.

In a globalized world, knowledge dissipates beyond national borders via trade and foreign direct investments (FDI) where heterogeneous IPR institutions are in place. In particular, developed and developing countries take a different view on IPRs: As technology leader, developed countries take a strong interest in the protection of domestic innovations. Developing countries, on the other hand, are lagging in technological development and not capable of efficient innovation themselves. Therefore, they benefit more from access to advanced technologies for imitation and production rather than from strong IPR protection or knowledge spillovers they might be unable to absorb.

Much of international growth theory has centered on this principle opposition of innovative developed countries and imitative developing countries. However, fortunately, there are multiple cases in which countries could break out of their backward position to emerge towards the technological frontier, with Japan and the Asian Tiger states as the prime examples. What is more, further countries have started out on the transition path. A clear indication is that developing countries start to invest in innovation. For instance, expenditures on R&D in non-OECD countries as a share of global R&D increased from less than 12% to over 18% from 1996 to 2005. For 2007, the UNESCO Institute for Statistics reports that developing countries accounted for almost 24% of world R&D expenditures and employed approximately 38% of world researchers. At the same time, advanced countries like the USA start to invest in R&D in Asian emerging countries via FDI.

Despite its significance for the development of countries, this emerging process of lagging economies has received little attention in the theoretical growth literature in which countries are usually assigned static roles as innovators or imitators. My research, therefore, is centered around the questions emerging countries face as they extend their economic activities to innovation: How can resources be redirected towards knowledge accumulation and creation? How can spillovers from FDI be used to access foreign knowledge? How have IPRs to adjust to promote innovation and how can losses in the imitation sector be compensated?

In the first two chapters of my dissertation, I approach these questions from a theoretical point of view. My work is based on North-South models with innovative developed countries (North) and imitative developing countries (South). This setup is extended to analyze the development of an innovation sector in the South and its implications for the choice of IPR institutions.

The first chapter of my dissertation, *Intellectual Property Rights as determinants of FDI, technology spillovers and R&D in developing economies*, based on a paper of the same name, focuses on the interplay of imitation, innovation and FDI in the development of a competitive southern innovation sector. Emerging countries benefit from the inflow of knowledge from advanced economies which possess superior technologies and experience in innovation. For policy makers in developing countries, striking the balance between the promotion of FDI, nurturing a growing domestic innovation sector and allowing imitation is necessary while policy measures can be contradicting and ineffective. The paper shows that the knowledge capital embodied in FDI supports the domestic R&D sector. Impediments to FDI as an attempt to reduce competition for domestic research fail as they primarily hamper technology adaption. Stronger IPR protection leads to a transfer of R&D to emerging countries. However, the extension of FDI potentially crowds out domestic innovations.

In the second chapter, *Imitation and Innovation Driven Development under Imperfect Intellectual Property Rights*, based on joint work with Monique Newiak under the same name, we allow for southern R&D and imitation directed to innovations originating in both regions. The South can set the level of IPRs and discriminate between protection for domestic and foreign firms to balance its interests in imitation and the promotion of domestic innovation. We find the effects of IPRs on R&D and welfare to be non-monotonic and dependent on the R&D efficiency and an innovation threshold in the South. For sufficiently strong IPRs, the South engages in R&D and stronger IPRs promote southern R&D, welfare, and reduce the North-South wage gap. Below the R&D threshold, a strengthening of IPR protection fails to promote R&D and decreases welfare and wages. Stronger IPRs exclusively for southern firms can benefit both regions by shifting southern resources from the imitation of northern goods to original southern innovation.

The third chapter, *Robust FDI determinants, Intellectual Property Rights and Parameter Heterogeneity*, based on joint work with Theo Eicher and Monique Newiak, investigates the importance of IPRs for binational FDI flows. The empirical study of FDI determinants allows to make inferences about the components, motives and adversaries of foreign investments which, in light of potential knowledge spillovers associated with FDI, is crucial knowledge for policy makers. We particularly focus on the analysis of different IPR measures to explain the intensive and extensive margins of FDI. Using Heckit Bayesian Model Averaging, we address both model uncertainty and the selection problem inherent in FDI data. To reveal parameter heterogeneities, we estimate the complete sample and split the observations for developed and developing host countries. For the global sample, we find that patent enforcement and the protection of patent rights attract FDI flows whereas trademarks increase the probability to invest in FDI but reduce the volume. The separate analysis shows that (1) for developed countries, IPR protection in the host country has a large influence on FDI flows whereas (2) IPR protection in the source country is more relevant for investments into developing countries. This indicates that FDI flows into developed countries contain more sensitive knowledge capital and are more likely deterred by risks of leakages to competitors in the host country than FDI flows into developing countries.

Chapter 1

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

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

*I thank Theo Eicher, Monique Newiak, Matthias Doepke and Steve Turnovsky for helpful comments and suggestions. The paper has also greatly benefited from the comments and suggestions by seminar participants at the University of Munich and the University of Washington. All remaining errors are mine. I thank the University of Washington for their support and hospitality during the preparation of this paper. I gratefully acknowledge financial support from the German Research Foundation through GRK 801.

1.1 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 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

[1]The UNESCO Institute for Statistics.
[2]Ukraine, Slovakia, Latvia, Lithuania, Hungary, Estonia and Croatia.

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 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 domestic innovation 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.

[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.

1.2 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 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

[4] In an extended version of the model with weak-scale effect and trade costs, Gustafsson and Segerstrom (2010) derive similar conclusions.

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 to 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 imitation 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, chapter 2 (Lorenczik and Newiak, 2011) shows 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.[5] These papers exclude an FDI sector as a source for knowledge accumulation and technology transfer which reduces the trade-off to the resource allocation between innovation and imitation.

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.

[5] The 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.

1.3 Model

1.3.1 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 base 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. Existing innovations in the North are not transferred to the South via FDI.[6]

[6]For models that analyze a shift of northern innovations to the South, see Gustafsson and Segerstrom (2011) and Glass and Saggi (2002, 1998)

1.3.2 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 $L_t^N = L_0^N e^{g_L t}$ and $L_t^S = L_0^S e^{g_L t}$, respectively. Households in the two regions are identical concerning their preferences and maximize the discounted lifetime flow of utility[7]

$$U(t) = \int_t^{\infty} e^{-(\rho - g_L)t} \ln u(t) dt, \quad u(t) = \left[\int_0^{n_t} x_{j,t}^{\alpha} dj \right]^{\frac{1}{\alpha}} \tag{1.1}$$

where ρ 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 differentiated varieties available on the world market; $x_{j,t}$ is the per capita quantity demanded of variety j, and α is a measure of the degree of product differentiation with $0 < \alpha < 1$, where smaller values of α imply a higher product differentiation. It is related to the elasticity of substitution between varieties σ by $\sigma = \frac{1}{1-\alpha}$. 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, $\bar{x}_{j,t} = \frac{\bar{e}_t}{P_t} \left(\frac{p_{j,t}}{P_t} \right)^{-\sigma}$, where $\bar{e}_t$ represents average consumption

[7] 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.

expenditures per consumer defined as $\bar{e}_t = (e^N t L_t^N + e_t^S L_t^S)/L_t$; $p_{j,t}$ is the price of variety j and $L_t = L_t^N + L_t^S$. The aggregate price index is defined as $P_t = \left[\int_0^{n_t} p_{j,t}^{1-\sigma} dj\right]^{\frac{1}{1-\sigma}}$. 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 $\frac{\dot{e}_t}{e_t} = r_t - \rho$, and thus only increase over time if the market interest rate r_t exceeds the individual discount rate ρ.

1.3.3 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_R^N, FDI-financed innovations in the South, n_F^S, of which n_C^S are imitated in the South, and original southern innovations n_R^S, i.e. $n = n_R^N + n_F^S + n_C^S + n_R^S$. 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:

$$\dot{n}_R^N = \frac{n^\theta \ell_R^N}{a_N} \tag{1.2a}$$

$$\dot{n}_F^S + \dot{n}_C^S = \frac{n^\theta \ell_F^S}{a_S \phi} \tag{1.2b}$$

$$\dot{n}_R^S = \frac{n^\theta k^S \ell_R^S}{a_S} \tag{1.2c}$$

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 $k^S = \frac{n_R^S + n_F^S + n_C^S}{n}$. 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] ϕ measures additional costs 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 or frictions from an unfamiliar business environment.[10] I assume that those factors are, to some extent, deliberately set by the South. The closer ϕ is to 1, the fewer impediments to northern investments exist.

The risk of imitation for FDI firms is given by the imitation rate $i = \frac{\dot{n}_C^S}{n_F^S}$. 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

[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.

[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).

is not enforced by the South.[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.

1.3.4 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_R^N, v_F^S and v_R^S 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 (1.2) and are determined by the amount of labor needed times the wage rate. The costs are given by

$$v_R^N = \frac{a_N w^N}{n^\theta} \tag{1.3a}$$

$$v_F^S = \frac{a_S \phi w^S}{n^\theta} \tag{1.3b}$$

$$v_R^S = \frac{a_S k^S w^S}{n^\theta} \tag{1.3c}$$

[11]This notion of IPR protection is used in, among others, Grossman and Lai (2004) and Gustafsson and Segerstrom (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-Peñalosa (2008).

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 $\frac{\pi_R^N}{v_R^N} + \frac{\dot{v}_R^N}{v_R^N} = r^N$, i.e. per period profits π_R^N 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 $\frac{\pi_F^S}{v_F^S} + \frac{\dot{v}_F^S}{v_F^S} - i = r^S$. From (1.3) follows a constant change in firm value of $\frac{\dot{v}}{v} = -\theta g$, where $g \equiv \frac{\dot{n}}{n}$ is the growth rate of the total number of varieties. The no-arbitrage conditions give the appropriately discounted profits and can be written as

$$v_R^N = \frac{\pi_R^N}{r^N + \theta g} \tag{1.4a}$$

$$v_F^S = \frac{\pi_F^S}{r^N + \theta g + i} \tag{1.4b}$$

$$v_R^S = \frac{\pi_R^S}{r^S + \theta g} \tag{1.4c}$$

Both costs (1.3) and discounted profits (1.4) determine the relative number of varieties in equilibrium.

1.3.5 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 α. The only exception are imitated goods that are priced at marginal costs. The prices for each variety are given by

$$p_R^N = \frac{w_N}{\alpha}, \qquad p_F^S = \frac{w_S}{\alpha} = p_R^S, \qquad p_C^S = w_S \tag{1.5}$$

The profit maximization problem of firms gives the instantaneous profits as

$$\pi_R^N = \frac{1-\alpha}{\alpha} w_N \bar{x}_R^N L \tag{1.6a}$$

$$\pi_F^S = \frac{1-\alpha}{\alpha} w_S \bar{x}_F^S L \tag{1.6b}$$

$$\pi_R^S = \frac{1-\alpha}{\alpha} w_S \bar{x}_R^S L \tag{1.6c}$$

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.

1.3.6 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: $L^N = \ell_R^N + \ell_Y^N$. In the South, labor is allocated into R&D funded by North and South and production of FDI, southern and imitated goods: $L^S = \ell_R^S + \ell_F^S + \ell_Y^S$. Labor supply is inelastic and wages adjust to equalize labor demand and supply in both regions.

1.4 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.

1.4.1 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 (1) 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 $\omega \equiv w^N/w^S$, the variety shares $\gamma_R^N \equiv n_R^N/n$, $\gamma_F^S \equiv n_F^S/n$, $\gamma_R^S \equiv n_R^S/n$ and $\gamma_C^S \equiv n_C^S/n$, 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 $g \equiv \dot{n}/n = \dot{n}_R^N/n_R^N = \dot{n}_F^S/n_F^S = \dot{n}_R^S/n_R^S = \dot{n}_C^S/n_C^S$. Dividing (1.2a) by n and using the fact that the R&D employment ratio ℓ_R^N/L^N is constant in steady state, the equilibrium growth rate is determined as

$$g = \frac{g_L}{1-\theta} \tag{1.7}$$

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.

1.4.2 Equilibrium in R&D and product markets

Free entry drives profits from monopolistic competition, (1.4), down to equal the costs of innovations (1.3). This results in the following steady-state cost-benefit conditions

$$\frac{a_N}{n^\theta} = \frac{\frac{1-\alpha}{\alpha}\bar{x}_R^N L}{\rho + \theta g} \tag{1.8a}$$

$$\frac{a_S \phi}{n^\theta} = \frac{\frac{1-\alpha}{\alpha}\bar{x}_F^S L}{\rho + \theta g + i} \tag{1.8b}$$

$$\frac{a_S}{n^\theta k^S} = \frac{\frac{1-\alpha}{\alpha}\bar{x}_R^S L}{\rho + \theta g} \tag{1.8c}$$

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 (1.8) by each other and using the relative demand quantity $\frac{\bar{x}_i}{\bar{x}_j} = \left(\frac{p_i}{p_j}\right)^{-\sigma}$, the equilibrium values of the relative wage, $\frac{w^S}{w^N}$, and the fraction of global innovations originating in the South, k^S, can be determined:

$$\left(\frac{w^S}{w^N}\right)^\sigma = \frac{a_N}{a_S \phi}\frac{\rho + \theta g}{\rho + \theta g + i} \tag{1.9a}$$

$$k^S = \frac{1}{\phi}\frac{\rho + \theta g}{\rho + \theta g + i} \tag{1.9b}$$

Equation (1.9a) 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 (1.8a) and (1.8b) 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 (1.9b) ensures that the cost-benefit conditions for FDI (1.8b) and innovation by southern firms (1.8c) hold simultaneously. Otherwise, FDI drives out southern innovation or vice versa. With higher impediments to FDI ϕ 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 ϕ and i require a high relative knowledge of the South to avoid a crowding out by FDI firms.[12]

From the definition of $k^S = \frac{n_R^S + n_F^S + n_C^S}{n} = \gamma_R^S + \gamma_F^S + \gamma_C^S = 1 - \gamma_R^N$ and (1.9b) follows the equilibrium share of northern innovations in all varieties

$$\gamma_R^N = 1 - \frac{1}{\phi} \frac{\rho + \theta g}{\rho + \theta g + i} \tag{1.10}$$

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 ϕ). Whenever the South increases its attractiveness for foreign investments, its share in innovation increases.

[12]The conditions have to be satisfied in equilibrium. However, i and ϕ have to be compatible with labor-market clearing such that the South cannot simply set $i = 0$ and $\phi = 1$ to achieve an equilibrium with high relative wages and knowledge capital.

1.4.3 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 1.3.6. This results in two steady-state conditions in two unknowns, the research intensity δ and the share of domestic southern innovations in global R&D, γ_R^S. $\delta \equiv \frac{n^{1-\theta}}{L^N}$ 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 δ 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 δ–γ_R^S–plane.

For the North, the labor market clearing condition from section 1.3.6 is combined with (1.2a), (1.8a) and the equilibrium value of γ_R^N to get the *northern steady-state condition*

$$1 = \delta a_N \left[1 - \frac{1}{\phi} \frac{\rho + \theta g}{\rho + \theta g + i}\right] \Delta \tag{1.11}$$

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 γ_R^N and a constant of demand and preference parameters Δ. The condition is invariant to whether R&D in the South is conducted by FDI or domestic firms and therefore vertical in the δ-γ_R^S-plane. As δ is the only variable, it determines the global equilibrium number of varieties. The share of northern labor allocated to innovation derives from (1.2a), (1.10), (1.11) and the definition of δ, which gives $\ell_R^N = \frac{g}{\Delta} L^N$, 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.[13] Neither distorts the cost-benefit condition for northern innovation (1.8a). Also indirect effects on the relative wage and knowledge capital n^{θ} do not change the allocation of labor in the North as profits from innovation and its costs change proportionately.

From the imitation rate follows that $\gamma_C^S = \frac{i}{g}\gamma_F^S$; together with (1.10) and given that the sum of variety shares equals one, the shares of FDI varieties and domestic innovations in the South are related by $\gamma_F^S = \frac{g}{g+i}\left(\frac{1}{\phi}\frac{\rho+\theta g}{\rho+\theta g+i} - \gamma_R^S\right)$. 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 ϕ. Changes in these parameters change the relative size of γ_F^S and γ_R^S as well as their combined share.

Substituting the demand for FDI products and southern innovations from (1.8b,c), the labor costs of innovation from (1.2b,c) and the variety shares into the southern labor market clearing condition gives the *southern steady-state condition*

$$1 = \delta\frac{L^N}{L^S}a_S\Big(-\gamma_R^S\phi\Lambda_S(i) + \Lambda_I(i)\Big) \tag{1.12}$$

where $\Lambda_S(i)$ and $\Lambda_I(i)$ are positive functions of the imitation rate i.[14] The negative factor on γ_R^S 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 market clearing condition is thus upward sloping in the δ–γ_R^S–plane.

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

[14] The slope constant is given by $\Lambda_S(i) \equiv i\frac{\left[(\rho+\theta g)^2+i(\rho+\theta g)\right]\frac{\alpha(\alpha^{-\sigma}-1)}{1-\alpha}-\left[g^2+ig\right]}{(g+i)(\rho+\theta g)} > 0$ with $\frac{\partial\Lambda_S}{\partial i} > 0$, and the intercept by $\Lambda_I(i) \equiv (\rho+\theta g)\left[\frac{g}{\rho+\theta g+i} + \frac{g+\alpha^{-\sigma}i}{g+i}\frac{\alpha}{1-\alpha}\right] > 0$ with $\frac{\partial\Lambda_I}{\partial i} > 0$. The results are established using $\rho+\theta g > g$ from the household problem and $\frac{\alpha(\alpha^{-\sigma}-1)}{1-\alpha} \geq 1$.

It has a positive δ-intercept $L^S(L^N a_S \Lambda_I)^{-1}$. The equilibrium on the labor market is given by the intersection of both steady-state conditions which determines the research intensity δ and the share of southern domestic varieties γ_R^S as shown in figure 1.1. In the following, I assume that the equilibrium exists and satisfies $0 \leq \gamma_F^S, \gamma_R^S < 1$.[15]

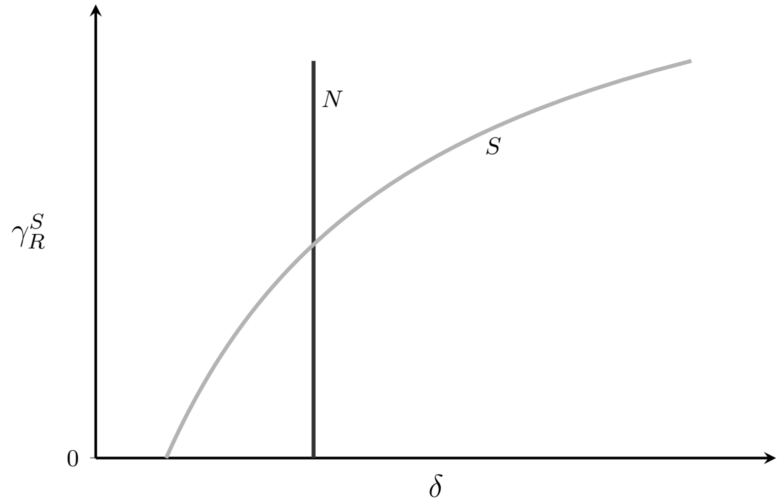

Figure 1.1: Equilibrium in the δ–γ_R^S–plane.

1.4.4 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. $A^N = n_R^N v_R^N + n_F^S v_F^S$. Substituting by (1.4) yields $A^N = (\gamma_R^N a_N w^N + \gamma_F^S \phi w^S) n^{1-\theta}$. The southern aggregate asset value A^S consists of southern innovating firms, so that it is given by $A^S = n_R^S v_R^S = \gamma_R^S a_S w^S \phi \frac{\rho+\theta g+i}{\rho+\theta g} n^{1-\theta}$. It follows

[15]See section 1.5.3 for details.

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 $P_t = n_t^{1/(1-\sigma)}\Big(\gamma_R^N(p_R^N)^{1-\sigma} + \gamma_F^S(p_F^S)^{1-\sigma} + \gamma_R^S(p_R^S)^{1-\sigma} + \gamma_C^S(p_C^S)^{1-\sigma}\Big)^{1/(1-\sigma)}$, 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 $\dot{u}/u = \dot{c}/c = g/(\sigma - 1) \equiv g_c > 0$. 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_0^N and c_0^S.[16]

1.5 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 ϕ. 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 (1.11) and (1.12).

[16]This 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.

1.5.1 IPR protection

An increase in IPR protection in the South is represented by a decrease in the imitation rate i. From (1.9) 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, γ_R^N, reduces according to (1.10). The changes in the steady-state conditions are depicted in figure 1.2. 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 more attractive, the North funds more innovations in the South until equal return profiles for innovations in North and FDI are restored.[17]

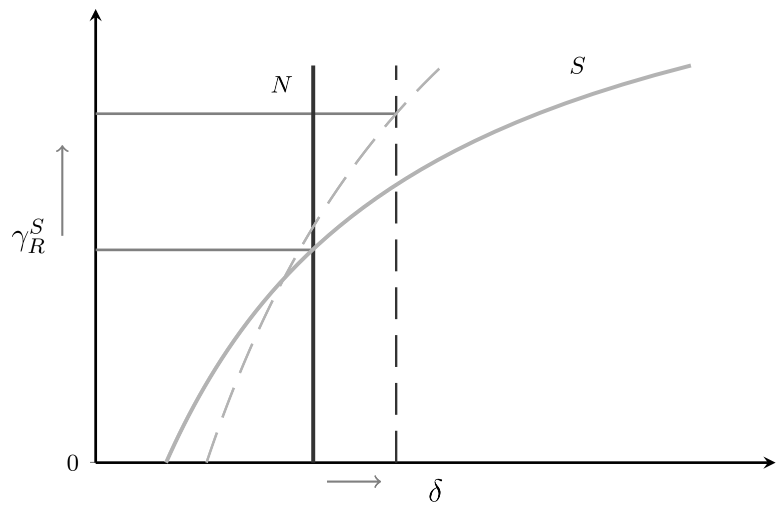

Figure 1.2: Equilibrium in the δ–γ_R^S–plane for $i\downarrow$.

For the southern steady-state condition, the δ 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

[17] As I assume perfect capital markets, firms are not financially constraint and can always invest in profitable innovations.

(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 δ, 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 δ. Which effects dominate depends on the share of original southern R&D, γ_R^S. For a low level of γ_R^S, 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 δ-intercept). For high γ_R^S, 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 γ_R^S. As (1.11) fully determines δ, it is used to substitute for δ in (1.12) to derive a formula in which γ_R^S is determined by model parameters only. It can be shown that the effect of higher IPR protection on γ_R^S in equilibrium depends on the strength of impediments to FDI ϕ. For low ϕ up to a threshold level $\bar{\phi}$, γ_R^S will increase. Above the threshold $\bar{\phi}$, the change in incentives is so large that γ_R^S decreases as γ_F^S absorbs more than the gain in global innovation share of the South.[18] This results from a higher incentive gain for FDI firms than for southern R&D when ϕ 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 ($i \downarrow$), the relative southern wage w^S/w^N and global innovation intensity δ increase and the innovation share of the North γ_R^N 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 γ_R^S. If $\phi > \bar{\phi}$, γ_R^S falls and FDI expands by more than the additional innovation share of the South.*

1.5.2 FDI policy

FDI impediments ϕ 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 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.[19] As more innovations originate in the

[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.

[19]Innovation in the North remains constant while innovation in the South expands such that relatively more innovations are developed in the South.

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 ϕ implies that the steady-state condition rotates to the left around the δ intercept: With a higher share in global innovation, more southern labor is used in the R&D sectors for any research intensity δ (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 γ_F^S is proportionate to the change in ϕ and just sufficient such that the innovation share effect, demand effect and FDI cost effect cancel out. This leaves the δ-intercept unchanged.[20] With a positive southern innovation share γ_R^S, 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 γ_R^S.

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, (1.9b), shows that the effect on k^S is stronger for small ϕ 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 1.3 and proposition 2 summarizes the effects.

[20]This can be seen from the southern labor market clearing condition (1.12) which is independent of ϕ when $\gamma_R^S = 0$. Thus, the δ-intercept does not change with ϕ.

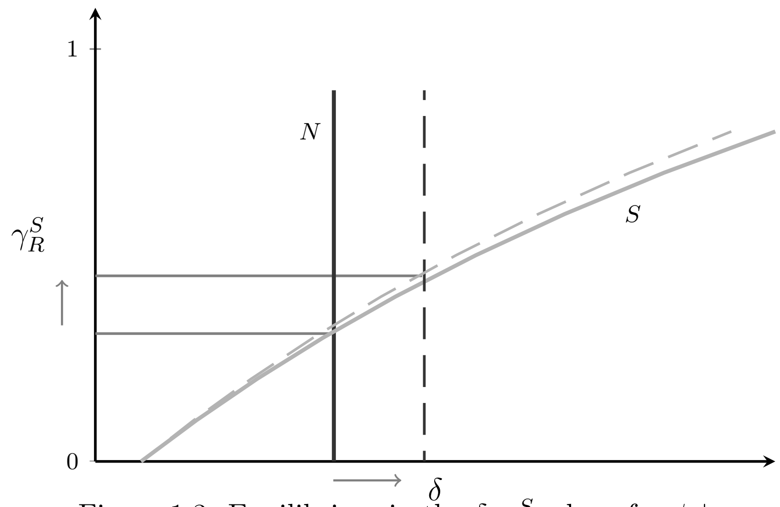

Figure 1.3: Equilibrium in the δ–γ_R^S–plane for $\phi\downarrow$.

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 ($[\gamma_R^N+\gamma_C^S+\gamma_R^S]\uparrow$) which raises the southern relative knowledge capital k^S. In the new equilibrium, the share of domestic innovations in the South, γ_R^S, and the research intensity, δ, increase unambiguously. If the policy change happens in an already FDI-friendly environment, the FDI share γ_F^S can potentially fall due to stronger local competition and the reduced wage difference.*

1.5.3 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 δ–γ_R^S–plane and $0\leq\gamma_F^S,\gamma_R^S<1$. No equilibrium including all sectors exists when (a) the northern steady-state condition lies to the left of the δ-intercept of the southern condition or (b) the intersection lies so far to the right that the cost-benefit conditions (1.8) 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 δ 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 $\gamma_F^S \geq 0$. The paper only considers interior solutions.

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.*

1.5.4 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.

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

[21]For the sake of comparability, the target moments are calibrated as in Gustafsson and Segerstrom (2011) and chapter 2 where applicable.

return over the past century estimated by Mehra and Prescott (1985). This implies a subjective discount rate ρ of the same value. Basu (1996) and Norrbin (1993) estimate a markup of 40% over marginal costs, determining the degree of differentiation between varieties α 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 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 $a_S = 2.5$. With impediments to FDI of $\phi = 2$, the research efficiency for FDI is halved compared to southern innovators (before knowledge differences). The imitation rate i is set to 10%. The wage rate in the North w^N is one and functions as numeraire such that w^S gives the southern relative wage.

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 1.1, 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 δ, 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 $\phi > \bar{\phi}$). Both regions gain from the policy change although the South falls short of the utility achieved in the FDI friendly environment.

Table 1.1: Stronger in IPR protection ($i \downarrow$)

FDI impediments		$\phi = 2$		$\phi = 4$	
Imitation rate	i	0.1	0.05	0.1	0.05
R&D intensity	δ	4.319	4.858	3.688	3.871
Innovation share N	γ_R^N	0.745	0.662	0.872	0.831
Innovation share S	γ_R^S	0.130	0.185	0.036	0.024
FDI share	γ_F^S	0.042	0.077	0.031	0.073
Imitation share	γ_C^S	0.083	0.075	0.061	0.072
Rel. knowledge capital S	k^S	0.255	0.338	0.128	0.169
Relative wage	w^S/w^N	0.521	0.564	0.427	0.463
Utility (p.c.) N	u_0^N	1.181	1.194	1.182	1.199
Utility (p.c.) S	u_0^S	0.550	0.602	0.438	0.469

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

Change of FDI policy

The simulation in table 1.2 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. γ_F^S, increase only moderately as domestic innovation in the South, with a diminishing knowledge disadvantage and increasing wage, becomes more competitive. For very low ϕ, 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.

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, γ_F^S, 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.*

[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.

Table 1.2: Reduction of FDI impediments ($\phi \downarrow$)

FDI policy	ϕ	4	3	2	1
R&D intensity	δ	3.688	3.876	4.319	6.567
Innovation share N	γ_R^N	0.872	0.830	0.745	0.490
Innovation share S	γ_R^S	0.036	0.061	0.130	0.496
FDI share	γ_F^S	0.031	0.037	0.042	0.005
Imitation share	γ_C^S	0.061	0.072	0.083	0.010
Rel. knowledge capital S	k^S	0.128	0.170	0.255	0.510
Relative wage	w^S/w^N	0.427	0.464	0.521	0.635
Utility (p.c.) N	u_0^N	1.182	1.182	1.181	1.172
Utility (p.c.) S	u_0^S	0.438	0.480	0.550	0.737

1.5.5 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 with loose IPR protection when impediments to FDI are high, 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.

1.6 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 for 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 challenges in the face of various spillover channels.

References

Agosin, M. R., Machado, R., 2005. Foreign Investment in Developing Countries: Does it Crowd in Domestic Investment? Oxford Development Studies 33 (2), 149–162.

Aitken, B., Harrison, A., 1999. Do domestic firms benefit from direct foreign investment? evidence from Venezuela. American Economic Review, 605–618.

Basu, S., 1996. Procyclical productivity: increasing returns or cyclical utilization? Quarterly Journal of Economics 111 (3), 719–751.

Borensztein, E., De Gregorio, J., Lee, J., 1998. How does foreign direct investment affect economic growth? Journal of international Economics 45 (1), 115–135.

Currie, D., Levine, P., Pearlman, J., Chui, M., 1999. Phases of imitation and innovation in a North-South endogenous growth model. Oxford Economic Papers 51 (1), 60–88.

Deardorff, A. V., 1992. Welfare Effects of Global Patent Protection. Economica 59 (233), 35–51.

Dixit, A., Stiglitz, J., 1977. Monopolistic competition and optimum product diversity. American Economic Review 67 (3), 297–308.

Eicher, T., García-Peñalosa, C., 2008. Endogenous strength of intellectual property rights: Implications for economic development and growth. European Economic Review 52 (2), 237–258.

Falvey, R., Foster, N., Greenaway, D., 2006. Intellectual property rights and economic growth. Review of Development Economics 10 (4), 700–719.

Glass, A., 2010. Imitation as a stepping stone to innovation. working paper.

Glass, A., Saggi, K., 1998. International technology transfer and the technology gap. Journal of Development Economics 55 (2), 369–398.

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

Grossman, G., Lai, E., 2004. International protection of intellectual property. American Economic Review 94 (5), 1635–1653.

Gustafsson, P., Segerstrom, P., 2010. North-South trade with increasing product variety. Journal of Development Economics 92 (2), 97–106.

Gustafsson, P., Segerstrom, P., 2011. North-South trade with multinational firms and increasing product variety. International Economic Review 52 (4), 1123–1155.

Helpman, E., 1993. Innovation, imitation, and intellectual property rights. Econometrica 61 (6), 1247–1280.

Ianchovichina, E., Walmsley, T., 2003. The impact of China's WTO accession on East Asia. World Bank Policy Research Working Paper No. 3109.

Javorcik, S., 2004. The composition of foreign direct investment and protection of intellectual property rights: Evidence from transition economies. European Economic Review 48 (1), 39–62.

Jones, C. I., 1995. R&D-based Models of Economic Growth. Journal of Political Economy 103 (4), 759–784.

Jones, C. I., 2005. Growth and ideas. In: Handbook of Economic Growth. P. Aghion and S. Durlauf, pp. 1063–1111.

Lai, E., 1998. International intellectual property rights protection and the rate of product innovation. Journal of Development Economics 55 (1), 133–153.

Lall, S., 2002. FDI and development: research issues in the emerging context. In: Bora, B. (Ed.), Foreign Direct Investment: Research Issues. London; Routledge; 2002, pp. 325–345.

Lee, J., Mansfield, E., 1996. Intellectual property protection and US foreign direct investment. Review of Economics and Statistics 78 (2), 181–186.

Lorenczik, C., Newiak, M., 2011. Imitation and Innovation Driven Development under Imperfect Intellectual Property Rights. Working Paper.

Mehra, R., Prescott, E. C., 1985. The equity premium: A puzzle. Journal of Monetary Economics 15 (2), 145–161.

Newiak, M., 2011. The dual role of IPRs under imitation and innovation driven development. Working Paper.

Norrbin, S., 1993. The relation between price and marginal cost in US industry: a contradiction. Journal of Political Economy 101 (6), 1149–1164.

OECD, 2008a. Science, Technology and Industry Outlook 2008.

OECD, 2008b. The Internationalisation of Business R&D – Evidence, Impacts and Implications.

The Economist, 1999. Infatuation's end, 23rd Sep. 1999.

UIS, 2009. A Global Perspective on Research and Development. UIS Fact Sheet October 2009, No. 2.

UIS, 2011. Science and Technology Report, GERD by source of funds. UIS Data Centre June 2011.

United Nations, 2005. World Investment Report. Transitional Corporations and the Internationalization of R&D.

Van Elkan, R., 1996. Catching up and slowing down: Learning and growth patterns in an open economy. Journal of International Economics 41 (1-2), 95–111.

World Bank, 2009. World Development Indicators 2009.

World Bank, 2011. Doing Business. Doing business in a more transparent world 2012.

Xu, B., 2000. Multinational enterprises, technology diffusion, and host country productivity growth. Journal of Development Economics 62 (2), 477–493.

Chapter 2

Imitation and Innovation Driven Development under Imperfect Intellectual Property Rights*

Abstract

Developing countries employ about two fifth of the world's researchers, originate one quarter of world expenditures on R&D, and their inventions are subject to imitation. Nevertheless, the previous literature focuses on North-South setups in which the South is restricted to imitating northern inventions. To analyze the effects of intellectual property rights (IPR) policies on developed and developing countries we extend this literature to allow not only for southern R&D and imitation of northern goods, but also imitation targeted at southern innovations. We find the effects of IPRs on R&D and welfare to be non-monotonic and dependent on R&D efficiency and an innovation threshold in the South. For sufficiently strong IPRs the South engages in R&D and stronger IPRs promote southern R&D, welfare, and a reduction in the North-South wage gap. Below the R&D threshold a strengthening of IPR protection fails to promote R&D and decreases welfare and wages. Stronger IPRs exclusively for southern firms can benefit both regions by shifting southern resources from the imitation of northern goods to original southern innovation.

Keywords: Innovation, Imitation, Economic Growth, Intellectual Property Rights

*This chapter is based on joint work with Monique Newiak. I would like to thank Theo Eicher, Matthias Doepke, Gerhard Illing, Niloy Bose, Monika Piazzesi, Martin Schneider, Michele Tertilt, Philip Brock, Oksana Leukhina and Stephen Turnovsky for many helpful comments and suggestions. The chapter has also greatly benefited from the comments and suggestions by various conference participants at the European Economic Association meeting in Oslo, the Midwest International Trade Meeting in Madison, the DEGIT XV conference in Frankfurt, the European Workshop in Macroeconomics in Munich, the Warsaw International Economics Meeting, the Midwest Economic Association Meeting in St. Louis, the Southwestern Society of Economists meeting in Houston and the third PhD conference in Economics in Athens. I would also like to thank the seminar participants at the University of Munich and the University of Washington, Seattle, for their valuable comments. All remaining errors are mine.

2.1 Introduction

The distribution of R&D efforts between developed and developing countries is changing. In its Science, Technology and Industry Outlook, the OECD (2008) reports that the distribution of Gross domestic expenditures 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. UIS (2009)[1] reports an even higher share of developing countries in world R&D for 2007: developing countries accounted for almost 24% of world GERD and employed almost 38% of world researchers. The extent of investments into R&D is closely correlated with the level of domestic IPR protection. Figure 2.1 plots the Gross expenditures on R&D and GDP per capita against the Ginarte and Park patent index in 2005.[2]

For the group of countries associated with low levels of IPRs (below an index of about 3 to 3.5), R&D expenditures are below 1% with low variations. Above the threshold, there is a clear positive correlation between R&D efforts, the level of IPRs and GDP per capita.[3] Not only do the graphs show that there is a threshold level of IPRs which has to be reached for IPRs to be positively associated with R&D, but also that IPR protection

[1]The UNESCO Institute for Statistics.

[2]Data sources: R&D expenditures for 2007 from UIS (2009), IPR index for 2005 from Park (2008a), GDP per capita for 2007 and country codes are from United Nations Statistics Division: National Accounts. We thank Walter Park for sharing the data on the patent index.

[3]For earlier periods, i.e. before TRIPS was established, the plot looks qualitatively similar, but the data are somewhat shifted to the left, i.e. to lower levels of IPRs. See Park (2008a) for the sources of changes in the index. The same observation is made in Ginarte and Park (1997) who find that high income countries provide the highest level of IPR protection.

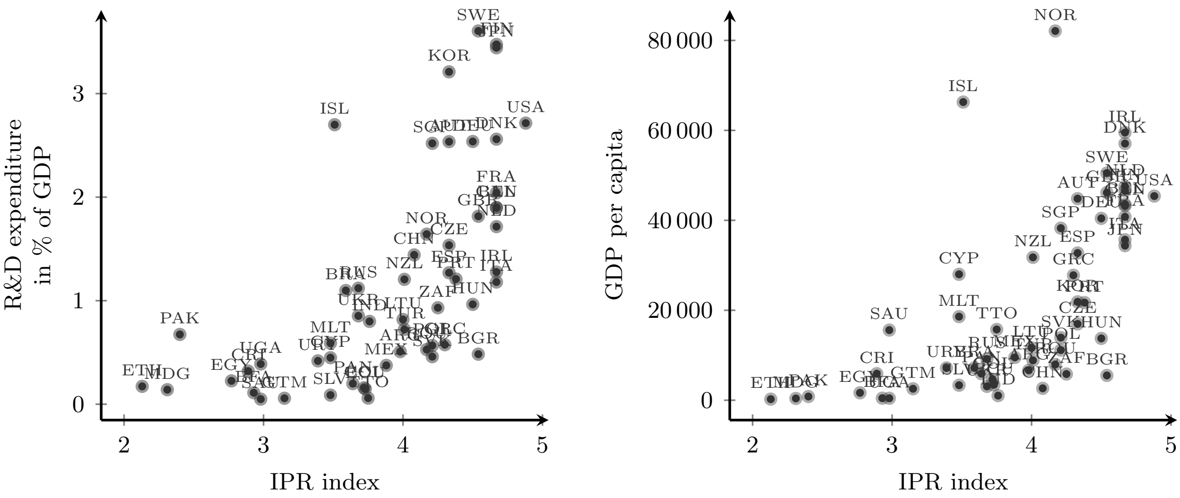

Figure 2.1: R&D expenditures (GERD), IPRs, and GDP per capita

is positively related to income in a country only if it supports a sufficiently developed R&D sector.[4]

The division of countries into industrialized innovating countries (the North) and imitating developing countries (the South) in the theoretical literature does not account for the increasing investments into R&D in developing economies shown by these recent surveys[5] and does not allow for scenarios of a transition of imitator countries to successful innovators as demonstrated by Asian Growth miracles like South Korea, Taiwan and earlier Japan.

In this chapter, we develop a North-South increasing variety model which allows for original innovation in both the North and the South, and also for the imitation of both

[4]That there is also a threshold level also for IPRs and growth which is dependent on the level of human capital in a country is shown by Mohtadi and Ruediger (2010) using a threshold estimation technique.

[5]Important contributions with this feature include Grossman and Helpman (1991), Deardorff (1992) and Helpman (1993) and more recently Gustafsson and Segerstrom (2010). For a criticism of the lack of southern R&D in North-South models see Park (2008b). For two examples of models in which the South can innovate, but is not the subject of imitation itself, see (Currie et al., 1999; Glass, 2010). For firms' private incentives to protect their intellectual property compare Eicher and García-Peñalosa (2008). For a countries decision to set the level of IPRs in a game theoretic framework see Grossman and Lai (2004).

northern and southern inventions. We show that our model can explain the IPR-R&D threshold level shown in figure 2.1, and determine the conditions under which IPRs can stimulate southern innovative activity and increase welfare. We then use the model to analyze the effects of different IPR policies in the South. For the policy analysis the aspect of southern firms also being subject to imitation has two main advantages: First, it allows us to analyze the effects of stronger IPRs on southern R&D incentives directly. Second, we can examine the effects of IPRs protecting northern or southern goods separately.

While international treaties such as the Paris and Berne Conventions prescribe the national treatment principle, i.e. equally strong protection for domestic and foreign innovations, this principle might not be followed by developing countries. For instance, as Kumar (2003) describes for the case of Japan until the 1970s, IPR legislation might be in place to unilaterally advance domestic technology adoption from abroad. Thus the second contribution of this chapter is to analyze the effects of discriminatory southern IPR policies on both regions.

We find that southern R&D takes place if IPRs surpass a critical threshold level. This critical level is lower for higher southern research efficiency and a larger southern population. This implies that large countries with efficient R&D sectors are likely to engage in innovation even under weak IPR regimes. Likewise, to stimulate an inefficient R&D sector in a small country, IPRs have to be very strong. In stimulating southern R&D, the protection of northern and the protection of southern innovations are shown to work as imperfect substitutes. If R&D takes place in the South, strengthening IPRs for both regions' innovators increases welfare in both regions. In contrast, an increase in IPRs that does not surpass the threshold level fails to stimulate R&D, increases the wage gap between the regions and decreases real consumption in the South.

We show that a southern deviation from the national treatment principle (increasing IPRs for domestic firms only), does not harm either region if southern R&D does not take place, and it benefits *both* regions if southern R&D is conducted: By increasing R&D incentives for southern firms, it shifts the southern attention away from the imitation of northern goods.

The next section discusses the related literature, and section 2.3 describes the model. In section 4, we describe the equilibrium, state the conditions under which southern R&D takes place and analyze the effects of different IPR policies on innovative and imitative activity and wages in the two regions. In section 5, the model is calibrated to analyze the welfare and employment effects of stronger IPRs, and section 6 concludes.

2.2 Related literature

In this section, we compare our results to the conclusions drawn by papers which are most closely related to our work. These papers are different from the seminal North-South models by, i.a., Grossman and Helpman (1991), Deardorff (1992) and Helpman (1993) in that they do not focus on the conflict *between* the innovating North and the imitating South, but are more concerned with the trade-off between imitation and innovation *within* the South.

In Currie et al. (1999), the South has the options to imitate the North or innovate with knowledge dissipating gradually from the North to the southern knowledge base. While not treating the effects of changes in IPRs explicitly, Currie et al. (1999) argue that subsidies to the imitation sector have qualitatively the same effects as a loosening of IPRs. The following features distinguish our model from Currie et al. and lead to partially different results: First, we analyze the problem in a semi-endogenous framework to match the empirical observations of non-scale growth as in Jones (1995). Thus policy changes do not imply long-run changes of the growth rate in our model. Second, we include the empirical feature of decreasing returns to R&D in imitation and innovation. This allows the South to engage in R&D even if the wage differences between the regions are large which is not possible in Currie et al.'s framework, but empirically more plausible. Third, while changes in subsidies to imitation do not have any welfare implications for the case in which the South only imitates in Currie et al. (1999), we show that in this no-innovation case, stronger IPRs for innovations of both regions decrease welfare, but can help to stimulate R&D if they surpass a threshold level. Finally and most importantly, we are able to analyze discriminatory IPR policies as we allow for southern goods to be subject to imitation as well. The protection of northern IPRs affects innovation incentives for the South only indirectly by making the alternative (imitation) more costly. In our model, general IPR protection has the direct benefit of increased expected profits for southern innovators. We show that IPRs exclusively for southern goods benefit both regions if southern R&D is present: they increase R&D profitability for the South and thus shift resources away from imitation of the North.

Glass (2010) also analyzes imitation and innovation in the South, but focuses on how imitation encourages R&D by providing the South with a sufficient knowledge base. She builds a product-cycle model in which an exogenous fraction of industries has to engage in imitation before being able to target the market for innovations and analyzes subsidies to northern and southern R&D and imitation. IPRs are not treated explicitly but indiscriminate subsidies to imitation and innovation are considered instead. The result suggests that when imitation is a prerequisite to southern innovation, undirected subsidies can increase the rate of innovation relative to imitation. However, these policies do not have any implications for the wage rate if the South innovates, and welfare changes are not considered in her paper. We emphasize that the focus of this chapter is different from Glass (2010): While she analyzes how imitation can serve as a stepping stone to innovation, this chapter examines how the South's choice between innovation and imitation is influenced by different IPR policies.

Newiak (2011) analyzes how imitation can encourage R&D in countries whose innovation sector is small compared to those in which the R&D sector is sufficiently large. The results of her model suggest that the effect of IPR policies depend crucially on the state of the R&D sector's development and the main channel of knowledge accumulation in the country. The model does not allow for imitation of southern products so that IPR policies considered in the two papers are different: while in Newiak (2011) an increase in IPRs always means that one source of knowledge is harder to access, we reveal a channel through which stronger IPRs are never harmful to R&D and welfare in the South while they can also benefit the North: stronger IPRs for southern innovations.

2.3 The Model

2.3.1 Basic setup of the model

Two regions interact in our model, a group of developed countries (the North) and a group of developing countries (the South). Firms in North and South hire labor for the production of consumption goods and for innovative and imitative research and development (R&D). Labor is perfectly mobile within all sectors across one region, but immobile between the two regions. Thus a single wage rate is paid to all workers within one region. Trade between the two regions is costless. North and South differ in their R&D activities. The North engages in innovation only. As long as a northern variety has not been imitated, its production takes place in the North, and the innovating firm charges the monopoly price on the global market. Once a northern variety has been imitated by the South, its production shifts to the South. The South engages in innovation and the imitation of both northern and southern inventions. If a southern variety has been imitated, its production stays in the South, but it is produced at lower costs by southern imitators.

2.3.2 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 he supplies inelastically to the labor market. So the labor supply in North and South at time t is given by $\ell_t^* = \ell_0^* e^{g_L t}$ and $\ell_t = \ell_0 e^{g_L t}$, respectively.[6] Households in the two regions are identical concerning their preferences and symmetric in their maximization problem. We restrict the outline of the household's problem to the South in the following. Agents in the South maximize the discounted lifetime flow of utility

$$U(t) = \int_t^{\infty} e^{-(\rho - g_L)t} \ln u(t) dt, \qquad u(t) = \left[\int_0^{N_t} x_{j,t}^{\alpha} dj \right]^{\frac{1}{\alpha}} \tag{2.1}$$

arising from the consumption of N_t differentiated varieties in each period. $\rho > g_L$ is the rate of time preference. $x_{j,t}$ denotes the per capita quantity demanded of variety j and α is the degree of product differentiation so that the elasticity of substitution between varieties is $\varepsilon = \frac{1}{1-\alpha}$. Individuals are constrained by their wage and asset income: $\dot{a}_t = (r_t - g_L)a_t + w_t - e_t$ in which e_t stands for consumption expenditure, w_t represents the wage income and r_t is the interest rate paid on asset holdings a_t. Solving the consumer's

[6]Throughout this dissertation the convention is used to indicate quantities referring to the North by '*' and to use no superscript for quantities of the South.

maximization problem for both regions we obtain $\bar{x}_{j,t}$, the average per capita demand for variety j by the world consumer at time t:

$$\bar{x}_{j,t} = \frac{\bar{e}_t}{P_t}\left(\frac{p_{j,t}}{P_t}\right)^{-\varepsilon} \tag{2.2}$$

in which $\bar{e}_t$ represents average consumption expenditures per consumer defined as $\bar{e}_t = (e_t^* \ell_t^* + e_t \ell_t)/L_t$, $p_{j,t}$ is the price of variety j and $L_t = \ell_t + \ell_t^*$. The aggregate price index is defined as $P_t \equiv \left[\int_0^{N_t} p_{j,t}^{1-\varepsilon} dj\right]^{\frac{1}{1-\varepsilon}}$. Expenditures in the South grow at $\frac{\dot{e}_t}{e_t} = r_t - \rho$ such that individual consumption expenditures e_t grow over time only if the market interest rate r_t exceeds the discount rate ρ.

2.3.3 Research and Development

Innovation

Varieties are invented in the North and in the South. The total amount of varieties invented in the North is given by $n_t^* = n_{R,t}^* + n_{C_N,t}$ in which $n_{R,t}^*$ and $n_{C_N,t}$ represent the number of not imitated and imitated varieties, respectively. Similarly, $n_t = n_{R,t} + n_{C_S,t}$ is the total number of varieties invented in the South with $n_{R,t}$ not yet imitated and $n_{C_S,t}$ already imitated innovations. The total number of varieties available to the world consumer is then given by:[7]

$$N = n^* + n = n_R^* + n_{C_N} + n_R + n_{C_S}. \tag{2.3}$$

To produce a new variety, R&D firms in the North and South have to develop an innovation blueprint. To obtain this innovation blueprint they hire researchers ℓ_R^* and ℓ_R.

[7]To simplify the notation we drop time scripts whenever no risk of ambiguity arises.

The employed researchers' productivity depends on the available amount of knowledge capital which we model as a function of the number of already existing varieties: N^θ. We assume that it is available to both regions equally, but that the regions differ in how efficiently they use it:

$$\dot{n}^* = \dot{n}_R^* + \dot{n}_{C_N} = \frac{\ell_R^* N^\theta}{ag} \tag{2.4a}$$

$$\dot{n} = \dot{n}_R + \dot{n}_{C_S} = \frac{\ell_R N^\theta}{ag\beta}, \quad \beta > 1, \quad 0 < \theta < 1, \quad g \equiv \frac{\dot{N}}{N}. \tag{2.4b}$$

We follow Jones (1995) and Gustafsson and Segerstrom (2011) in setting $0 < \theta < 1$ such that the R&D difficulty is decreasing in the number of blueprints, intertemporal knowledge spillovers become weaker over time and strong scale effects are ruled out. The parameter a captures the difficulty to innovate in the North so that $\beta > 1$ means that the South is relatively less productive in the innovation process. Further we account for decreasing returns to innovation by letting the global variety growth rate $g \equiv \frac{\dot{N}}{N}$ enter the innovation functions in the denominator.[8]

Imitation

Imitation takes place in the South only. In order to obtain the imitation blueprint of a northern or southern innovation, imitation firms hire labor ℓ_{C_N} and ℓ_{C_S} and use the existing knowledge capital N^θ. In modelling imitation as a costly process we follow the

[8]The growth rate g in the denominator captures decreasing returns to innovation as follows: The total number of varieties invented in period t by both regions is $\dot{N}_t = \frac{\ell_R^* N^\theta}{ag} + \frac{\ell_R N^\theta}{ag\beta} = \frac{N_t^\theta}{ag}(\ell_R^* + \ell_R/\beta)$. Given the definition of g, this expression can be rewritten as $\dot{N}_t = \left(\frac{N_t^{1+\theta}}{a}(\ell_R^* + \ell_R/\beta)\right)^{1/2}$ which implies decreasing returns to innovation. For literature on decreasing returns to innovation, compare Griliches et al. (1989) and Kortum (1993).

study by Mansfield et al. (1981) who find average imitation costs of about 65% and an imitation time requirement of 70% compared to innovation. So the imitation functions for northern and southern products are described as:

$$\dot{n}_{C_N} = \frac{\ell_{C_N} N^{\theta}}{\phi_N d a \iota_N}, \quad \iota_N = \frac{\dot{n}_{C_N}}{n_R^*} \tag{2.5a}$$

$$\dot{n}_{C_S} = \frac{\ell_{C_S} N^{\theta}}{\phi_S a \iota_S}, \qquad \iota_S = \frac{\dot{n}_{C_S}}{n_R}. \tag{2.5b}$$

ϕ_N and ϕ_S capture the difficulty of imitating northern and southern varieties and are interpreted as the strength of IPR protection in the South. The higher ϕ_N and ϕ_S, the stronger the level of IPR protection and the higher the costs of imitation. Note that we allow for different IPR levels for the inventions from the two regions, so that the South is allowed to discriminate between domestic and foreign firms. ι_N and ι_S are the imitation rates of northern and southern varieties which enter the imitation functions as in Gustafsson and Segerstrom (2011), but with an elasticity of imitation supply of one. Including the imitation rates in the imitation functions again captures the idea of decreasing returns to R&D[9]. Finally, we introduce a distance parameter d to allow for a higher imitation difficulty for northern varieties (due to the remote original development and production and possibly higher technological sophistication).

As they operate in the same region as the innovator, imitators of southern goods do not have a labor cost advantage. In order to generate positive profits from imitation, they hire process innovators who improve the production process such that the imitating firm can produce the variety cheaper than the innovation firm. The cost advantage in production η is a positive function of the amount of process innovators ℓ_P employed and

[9] Compare footnote 8.

a negative function of the cost of developing the imitation blueprint: If it is difficult to copy the technology in the first place, improving the production process should be also more difficult. So η is modeled as a negative function of the labor input ℓ_{C_S} needed to develop the imitation blueprint: $\eta = \bar{\eta}\left(\frac{\ell_P}{\ell_P+\ell_{C_S}}\right)^{\frac{1}{\gamma}}$ with $\eta \in [0, \bar{\eta})$, implying an upper bound for the cost reduction and γ as the difficulty to improve the production process.

2.3.4 Production

Labor is the only factor of production. For northern and southern innovators, one unit of labor produces one unit of output. As long as the invention has not been imitated, innovators have monopoly power and maximize their profit $\pi_R^{(*)} = (p_R^{(*)} - w_t^{(*)})\bar{x}_R^{(*)} L$ subject to the demand function (2.2). Monopolists in the North and South charge a constant mark-up over their marginal costs w^* and w, such that prices and profits for northern and southern innovation firms are given by:

$$p_R^* = \frac{w^*}{\alpha}, \quad \pi_R^* = \frac{1-\alpha}{\alpha} w^* \bar{x}_R^* L \tag{2.6a}$$

$$p_R = \frac{w}{\alpha}, \quad \pi_R = \frac{1-\alpha}{\alpha} w \bar{x}_R L. \tag{2.6b}$$

In the case of imitation, imitators and innovators compete in prices which drives the price down to the innovator's marginal cost of production and the innovating firm shuts down. If the wage differential is not too high ($w^* \leq w/\alpha$), the southern imitator charges a price equal to the northern wage rate w^* to force the northern innovator out of the market. If the wage gap is high ($w/\alpha \leq w^*$), the imitator can charge the monopoly price.[10] As

[10]These cases are referred to as the narrow-gap case and the wide-gap case by Grossman and Helpman (1991).

none of our results depends qualitatively on whether narrow or wide gap case is present, we present the model for the wide gap case in the following and outline how the model changes for the narrow-gap case in appendix 2.A. Due to the process innovation described in the previous section, an imitator of southern innovations produces goods at lower marginal costs $(1-\eta)w$. We assume an upper bound on this cost advantage ($\eta \leq 1-\alpha$) so that the imitator charges a price equal to the southern wage rate. The price and the profits for imitated northern and southern goods are given by:

$$p_{C_N} = \frac{w}{\alpha}, \qquad \pi_{C_N} = \frac{1-\alpha}{\alpha} w \bar{x}_{C_N} L, \qquad w^* \geq \frac{w}{\alpha} \tag{2.7a}$$

$$p_{C_S} = w, \qquad \pi_{C_S} = \eta w \bar{x}_{C_S} L, \qquad \eta \leq 1-\alpha. \tag{2.7b}$$

2.3.5 Financial sectors

The value of an innovating or imitating firm v_R or v_C is given by its expected discounted profits. As there is free entry to R&D and imitation, these expected discounted profits have to be equal to the cost of the respective activity. For innovating firms, the cost consists of the wage paid to the researchers. For imitating firms, it is the wage paid to the reverse engineers (and process innovators for imitators of southern varieties). Using (2.4) and (2.5) to determine the amount of labor for these activities, the firm values for innovators in North and South and imitators in the South are:

$$v_R^* = \frac{w^* a g}{N^\theta} \tag{2.8a}$$

$$v_R = \frac{w \beta a g}{N^\theta} \tag{2.8b}$$

$$v_{C_N} = \frac{w \phi_N a \iota_N}{N^\theta} \tag{2.8c}$$

$$v_{C_S} = \frac{w \phi_S a \iota_S}{N^\theta (1 - (\eta/\bar{\eta})^\gamma)} \tag{2.8d}$$

There is perfect capital mobility between innovation, imitation and production sectors within one region, but financial autarky in North and South. Agents in the North can decide between holding the market portfolio with a safe return r^* or shares of the northern innovation firms which pay a return π_R^*/v_R^*. This return has to be adjusted by the change in the value of the firm $\dot{v}_R^*/v_R^*$ and the risk of being copied $\dot{n}_{C_N}/n_R^*$. In the South, agents have the choice between gaining the risk free rate r and holding shares of southern innovation or imitation firms. No-arbitrage between these choices within North and South implies:

$$\frac{\pi_R^*}{v_R^*} + \frac{\dot{v}_R^*}{v_R^*} - \frac{\dot{n}_{C_N}}{n_R^*} = r^* \tag{2.9a}$$

$$\frac{\pi_R}{v_R} + \frac{\dot{v}_R}{v_R} - \frac{\dot{n}_{C_S}}{n_R} = r = \frac{\pi_{C_N}}{v_{C_N}} + \frac{\dot{v}_{C_N}}{v_{C_N}} = \frac{\pi_{C_S}}{v_{C_S}} + \frac{\dot{v}_{C_S}}{v_{C_S}}. \tag{2.9b}$$

2.3.6 Labor markets

Finally, labor market clearing in the 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: $\ell^* = \ell_R^* + \ell_Y^*$. In the South, labor is allocated into R&D, the imitation of northern goods, the imitation of southern goods, process innovation and production: $\ell = \ell_R + \ell_{C_N} + (\ell_{C_S} + \ell_P) + \ell_Y$ which, using the innovation and imitation functions (2.4) and (2.5) implies the following two labor market clearing conditions:

$$\ell^* = \frac{ag}{N^\theta}(\dot{n}_R^* + \dot{n}_{C_N}) + n_R^* \bar{x}_R^* L \tag{2.10a}$$

$$\begin{aligned} \ell = & \frac{ag\beta}{N^\theta}(\dot{n}_R + \dot{n}_{C_S}) + \frac{ad\phi_N \iota_N}{N^\theta}\dot{n}_{C_N} + \frac{a\phi_S \iota_S}{N^\theta(1-(\eta/\bar{\eta})^\gamma)}\dot{n}_{C_S} \\ & + (n_R \bar{x}_R + n_{C_N}\bar{x}_{C_N} + (1-\eta)n_{C_S}\bar{x}_{C_S})L. \end{aligned} \tag{2.10b}$$

2.4 The balanced growth path and the effects of intellectual property rights

In this section, we define the equilibrium and analyze the conditions under which innovation takes place in the South. We then analyze the effect of different IPR policies for an equilibrium with southern innovation. The model without southern innovation is described in appendix 2.B.

2.4.1 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, varieties and their supply, consumption expenditures and asset holdings (1) solves the households' utility maximization problem and firms' profit maximization problem and (2) labor, goods and financial markets clear given the free market entry of firms. In this steady state equilibrium, variety growth $g \equiv \dot{N}/N$, the South-North wage ratio $\omega \equiv w/w^*$, the imitation rates ι_N and ι_S, the optimal cost advantage of southern imitative production $\eta^\star$, the variety shares $\xi_R^* \equiv n_R^*/N$, $\xi_R \equiv n_R/N$, $\xi_{C_N} \equiv n_{C_N}/N$ and $\xi_{C_S} \equiv n_{C_S}/N = 1 - \xi_R^* - \xi_R - \xi_{C_N}$, and the shares of labor employed in the different sectors of each region are constant. Further, constant consumption expenditures imply that the risk-free interest rates in North and South are equal to the rate of time preference $\rho = r^* = r$.

As the variety shares are constant in equilibrium, the number of available varieties of each type has to grow at the same rate $g \equiv \dot{N}/N = \dot{n}_R^*/n_R^* = \dot{n}_R/n_R = \dot{n}_{C_N}/n_{C_N} = \dot{n}_{C_S}/n_{C_S}$. Dividing (2.4) by N and using the fact that the R&D employment ratio ℓ_R^*/ℓ^* is constant in steady state the equilibrium growth rate is determined as

$$g = \frac{g_L}{1-\theta}. \tag{2.11}$$

The growth rate is finite and positive for $\theta < 1$. This semi-endogenous growth implies that policy actions do not have any effect on the long-run growth rate.

2.4.2 The threshold to innovation in the South

We turn now to answering the first question of this chapter: Which factors determine the innovation threshold observed in the data (compare figure 2.1)? To answer this question, we consider the conditions under which innovation and imitation are beneficial in the two regions: Rearranging the no-arbitrage conditions with respect to firm values and equating with (2.8) and realizing that $\dot{v}_R^*/v_R^* = \dot{v}_R/v_R = \dot{v}_{C_N}/v_{C_N} = \dot{v}_{C_S}/v_{C_S} = -\theta g$, we arrive at four conditions balancing profits and costs of innovative and imitative activities in North and South:

$$\frac{\pi_R^*}{\rho + \theta g + \iota_N} = \frac{w^* a g}{N^\theta} \tag{2.12a}$$

$$\frac{\pi_R}{\rho + \theta g + \iota_S} = \frac{w \beta a g}{N^\theta} \tag{2.12b}$$

$$\frac{\pi_{C_N}}{\rho + \theta g} = \frac{w \phi_N d a \iota_N}{N^\theta} \tag{2.12c}$$

$$\frac{\pi_{C_S}}{\rho + \theta g} = \frac{w \phi_S a \iota_S}{N^\theta (1 - (\eta/\bar{\eta})^\gamma)}. \tag{2.12d}$$

The left-hand side of (2.12) represents the benefit (the appropriately discounted profits) from innovation and imitation, whilst the right-hand side represents the cost (wage payments) of the respective activity.[11] These conditions are crucially affected by the level of IPRs (ϕ_S and ϕ_N): first, they directly determine the cost of imitation (the right-hand sides of (2.12c) and (2.12d)) and second, via their effect on the imitation rates, they affect the expected profits from innovation (the left-hand sides of equations (2.12a) and (2.12b)). As the South does only engage in R&D if the expected profits and the associated costs from performing R&D are at least as attractive as the imitation of northern varieties we thus expect three parameters to crucially influence the existence of southern innovation: First, the higher the relative research inefficiency β the higher the cost of developing one blueprint and the higher the required profits to cover these costs. Second, expected profits to R&D depend negatively on the risk of being imitated ι_S which is directly determined by the level of IPRs for southern innovations ϕ_S (which

[11] Note that the cost advantage in the production of southern products η is determined optimally by the southern imitation firm. To set η optimally, the marginal revenue (the increase in profits due to the decrease in the production costs) and the marginal cost of hiring a process innovator (the wage rate) are equated. Thus, both sides of (2.12d) are differentiated with respect to ℓ_P. The optimal cost advantage can then be written as $\eta^\star = \bar{\eta} \left(\frac{1}{1+\gamma}\right)^{\frac{1}{\gamma}}$.

we explicitly show in the next section). Third, the decision to engage in R&D depends on the ease of imitation of northern varieties which is influenced by the protection of northern goods ϕ_N: the lower ϕ_N the easier is imitation compared to innovation. Finally, the southern decisions have to be consistent with the southern resource constraint (labor market clearing).

Combining the southern cost-benefit conditions (2.12b)-(2.12d) with the southern labor market clearing equation, we obtain the condition under which employment in the southern innovation sector is positive:

$$\frac{\ell}{\ell^*} > d\phi_N \left(\frac{\iota_N}{g}\right)^2 \left(\frac{\Lambda_1}{\Lambda_1 + \iota_N}\right), \qquad \iota_N = \frac{\beta}{d\phi_N} \frac{\Delta_1 \phi_S(\rho + \theta g) g}{\Delta_1 \phi_S(\rho + \theta g) - \eta^\star \beta g} \tag{2.13}$$

with $\Lambda_1 = (1-\alpha)g + \alpha(\rho + \theta g)$. From (2.13) follows that the higher the protection of northern or southern innovations (the higher ϕ_S and ϕ_N) the more likely the South engages in research. Intuitively, the South is, c.p., more likely to engage in R&D if its research efficiency is high (β is low). For a given southern R&D efficiency, IPRs for northern and southern IPRs are substitutes to a certain degree: If ϕ_N is high and therefore the costs of imitating the North are high compared to conducting own research, expected profits from R&D can be smaller and therefore IPRs for southern goods can be weaker. Further, the higher the cost of original research in the South (the higher β) the stronger IPRs have to be for northern and southern products in order to make R&D comparatively profitable. Finally, the existence of southern R&D is more likely if the southern labor force is large. This implies that for given levels of IPR protection and research ability, large countries are more likely to engage in innovation. We plot the IPR threshold ($\ell_R = 0$) in figure 2.2 for illustration.

Innovation takes place for all combinations of ϕ_S and ϕ_N on the right-hand side of the isoquant. The figure demonstrates that the South can go from a phase of solely imitating

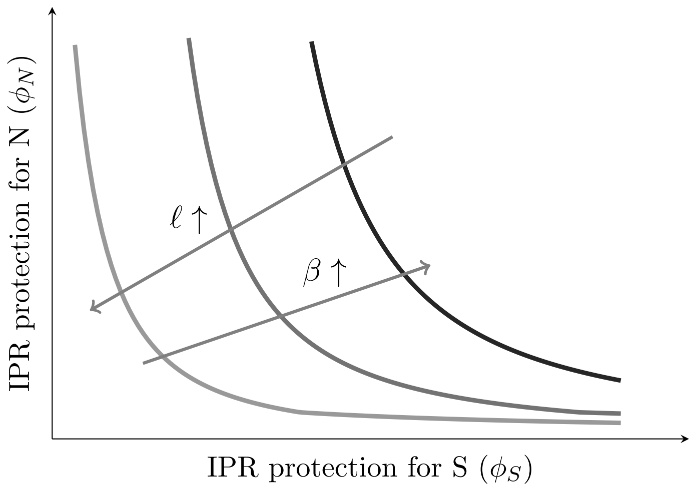

Figure 2.2: IPR threshold for southern research employment.

the North to a phase with own original R&D if the southern research efficiency or IPRs are sufficiently increased. It also reveals that in order to stimulate R&D in countries with a less efficient research sector IPR protection has to be stronger than in countries with efficient R&D sectors. The results are summarized in

Proposition 1 *(i) Stronger IPRs can stimulate southern innovation if they surpass a threshold level. (ii) This threshold level is higher the less efficient the southern research sector and the smaller the relative size of the southern population. (iii) The protection of southern and northern innovations work as imperfect substitutes in encouraging southern R&D.*

If (2.13) is not satisfied, the cost-benefit conditions (2.12b) and (2.12d) do not apply and the model collapses to the standard North-South model without southern innovation. While we focus on the case in which southern R&D takes place in the following, we describe the no-innovation case in appendix 2.B.

2.4.3 Intellectual property rights policy effects on the incentives to innovate and imitate

To obtain the rates at which northern and southern products are imitated, we combine the cost-benefit conditions (2.12b) and (2.12d) as well as (2.12a) with (2.12d), substitute for the profits and use the demands for varieties (2.2):

$$\iota_S = \frac{\eta^\star \beta(\rho + \theta g)g}{\Delta_1 \phi_S(\rho + \theta g) - \eta^\star \beta g} \tag{2.14a}$$

$$\iota_N = \frac{\beta}{d\phi_N} \frac{\Delta_1 \phi_S(\rho + \theta g)g}{\Delta_1 \phi_S(\rho + \theta g) - \eta^\star \beta g}, \tag{2.14b}$$

with $\Delta_1 = (1 - \alpha)\alpha^{\varepsilon - 1} \frac{(1+\gamma)}{\gamma}$.[12] Suppose first that the South follows the national treatment principle and chooses to protect domestic and foreign goods equally (formally: set $\phi_N = \phi_S = \phi$). Increasing ϕ will then decrease the rates at which domestic and foreign goods are imitated. However, the South could also choose to discriminate between domestic and foreign innovators by increasing only either ϕ_N or ϕ_S. Increasing IPRs for northern firms will decrease the rate at which northern firms are imitated, but leave the risk of being imitated for southern innovators unaffected. In contrast, if the South chooses to increase IPRs for domestic innovations only ($\phi_S \uparrow$), both rates of imitation decrease. This effect results from the impact of ϕ_S on southern innovation: If southern goods are better protected, southern innovators face a lower risk of being imitated and consequently their expected profits increase. This makes own innovation more attractive compared to the imitation of both northern and southern goods which leads to the decline of the imitation rates.

[12] As ι_S has to be non-negative, the parameters of the model are constrained to $\eta^\star \beta g < \phi_S \Delta_1(\rho + \theta g)$.

In line with this reasoning, policies which aim at increasing the southern research efficiency (decreasing β) decrease the imitation rates by decreasing the innovation costs and thus making southern innovation more attractive compared to imitation.

Proposition 2 *In an equilibrium with southern innovation, the rates at which northern and southern innovations are imitated are decreasing in (i) an increase in IPRs for all varieties, (ii) an increase in IPRs exclusively for southern innovations and (iii) an increase in the southern research efficiency. Increases in IPRs exclusively for northern goods decrease the imitation risk for northern goods, but leave the imitation rate for southern innovations unaffected.*

How do these changes of imitation risks relate to the allocation of labor into the different sectors in North and South? We use the northern labor market clearing condition and combine it with the cost-benefit conditions to get the amount of labor allocated into R&D and production in the North:

$$\ell_R^* = \frac{(1-\alpha)(g+\iota_N)}{\Lambda_1 + \iota_N}\ell^* \tag{2.15a}$$

$$\ell_Y^* = \frac{\alpha(\rho+\theta g+\iota_N)}{\Lambda_1 + \iota_N}\ell^*. \tag{2.15b}$$

The amount of labor employed in the northern R&D sector is increasing in the rate at which northern products are copied: If northern innovations are copied at a high rate, the production of northern inventions shifts to the South quickly. As a consequence, labor is set free from the production sector to the innovation sector. It follows that policies which decrease the imitation risks for northern firms ($\phi_N \uparrow$ or $\phi_S \uparrow$ or $\beta \downarrow$), also decrease the share of labor employed in the northern research sector.

To obtain the allocation of southern labor into the imitation of northern goods, we combine (2.15) with the imitation function for northern goods:

$$\ell_{C_N} = \frac{\phi_N \iota_N^2}{g} \frac{(1-\alpha)}{(\Lambda_1 + \iota_N)} \ell^*. \tag{2.16}$$

Using (2.14b), we can show that employment in the imitation sector for northern goods is decreasing in the strength of IPR protection for northern and southern goods ϕ_N and ϕ_S and increasing in the southern research inefficiency β. The higher the protection of northern goods ϕ_N, the costlier the imitation of northern goods, so that southern innovation and imitation of southern goods become more attractive. The higher the protection of southern goods ϕ_S, the smaller the risk of being copied for the South, the more attractive is southern research which shifts resources from the imitation of northern goods to own innovation. This result again reveals that an IPR policy in favor of domestic innovators (increase ϕ_S only) can shift resources away from the imitation of foreign innovations.

To obtain the number of workers employed in the southern innovation sector, we use (2.16) and the cost-benefit conditions (2.12b)-(2.12d) :

$$\ell_R = \left[\ell - \phi_N \left(\frac{\iota_N}{g}\right)^2 \left(\frac{\Lambda_1}{\Lambda_1 + \iota_N}\right) \ell^*\right] \frac{(1-\alpha)(g+\iota_S)}{\Lambda_1 + \iota_S + \frac{1-\alpha}{\eta^\star}\frac{\gamma+1}{\gamma}\frac{\phi_S}{\beta}\left(\frac{\iota_s}{g}\right)^2 \Lambda_2}, \tag{2.17}$$

in which $\Lambda_2 = \eta^\star g + (1-\eta^\star)(\rho+\theta g)$. Equation (2.17) consists of two terms. The number of workers which are *not* employed in the imitation of northern products and their production is given by the first factor. The second factor gives the fraction of these workers employed in original southern R&D. Southern R&D employment is increasing in the level at which northern and southern inventions are protected (ϕ_N and ϕ_S).[13] When protecting northern

[13] A sufficient (but not necessary) condition for the latter statement is that $\phi_S < \frac{2}{\Delta_1(\rho+\theta g)}$.

goods more strongly, imitation of these goods becomes more costly and thus becomes relatively unattractive compared to innovation, thus R&D employment increases. When protecting southern inventions more strongly, R&D employment increases for two reasons: First, imitation of southern products becomes more costly and therefore relatively less attractive compared to R&D. Second, southern R&D becomes more attractive as the risk of being imitated declines. We summarize these findings in the following proposition:

Proposition 3 *An increase in the level of IPRs for northern or southern goods or an increase in the efficiency of the southern research sector (i) increases employment in the southern research sector, (ii) decreases employment in the northern research sector and (iii) decreases employment in the imitation sector which targets northern goods.*

The effects of IPR policies on the labor allocated to the imitation of southern inventions $\ell_{C_S} = \frac{\phi_S \iota_S}{g\beta} \frac{\iota_S}{\iota_S + g} \ell_R$ is explored in the numerical part (section 2.5).

2.4.4 Policy effects of stronger intellectual property rights on wages and welfare

After analyzing how IPRs influence the southern incentives to innovate and imitate, we now look at whether these changes in incentives and labor allocation are beneficial to either of the regions. First, we look at the response of the wage differential between the two regions as a measure of their difference in development. Second, we outline the way we are going to measure changes in welfare due to IPR changes which will be quantified in the numerical section. Combining the cost-benefit conditions (2.12a) and (2.12b) with the equations for the imitation rates, we determine the relative wage between South and

North $\frac{w}{w^*}$:

$$\omega = \left(\frac{1}{\beta} + \frac{1}{d\phi_N(\rho + \theta g)} - \frac{\eta^\star}{\Delta_1 \phi_S(\rho + \theta g)} \right)^{\frac{1}{\varepsilon}}. \tag{2.18}$$

The relative wage between South and North is determined by the southern research inefficiency (β) and the IPRs for northern and southern goods (ϕ_N and ϕ_S). Intuitively, the more efficient the southern research sector compared to the northern one (the lower β), the lower the wage differential between the regions. The equilibrium wage reveals that the protection of northern and southern goods have different effects on how far the South is behind in terms of wages: Stronger protection of northern goods increases the wage gap, stronger protection for domestic innovators decreases the wage gap. While both IPR policies increase the cost of imitation, stronger protection for southern goods also raises the profitability of southern R&D and thus southern wages. Suppose again that the South follows the national treatment principle and protects northern and southern innovations equally strong ($\phi_N = \phi_S = \phi$). Then differentiating (2.18) with respect to ϕ gives the following condition:

$$\frac{\partial \omega}{\partial \phi} \gtrless 0 \quad \text{if} \quad \iota_S \gtrless \iota_N. \tag{2.19}$$

This condition says that stronger IPRs increase the southern wage rate relative to the northern one if southern products are imitated at a higher rate, but decreases it if northern products are subject to higher imitation. For the national treatment case $\iota_S > \iota_N$ is fulfilled if $d > \frac{\Delta_1}{\eta^\star}$. This says that stronger IPRs decrease the wage difference between the regions only if northern products are sufficiently difficult to imitate.

Proposition 4 *In an equilibrium with southern innovation, an increase in IPRs for southern innovations decreases the wage gap between South and North, while stronger IPRs for northern goods increase the wage gap. A simultaneous increase in IPRs for northern and southern goods decreases the wage differential between the regions only if northern innovations are sufficiently difficult to imitate.*

Finally, in order to make welfare predictions for IPR policy changes, we solve for asset holdings, consumer expenditures and the economic growth rate. The aggregate value of northern assets A^* is the product of the number of non-copied northern innovations and the value of a northern innovation firm $A^* = n_R^* v_R^*$. Substituting v_R^* by (2.8) yields $A^* = \xi_R^* w^* a g N^{1-\theta}$. The southern aggregate asset value A consists of the sum of the values of the assets from innovating and the two kinds of imitating firms, so that it is given by $A = \left(\xi_R g\beta + \xi_{C_N}\phi_N\iota_N + \xi_{C_S}\frac{1+\gamma}{\gamma}\phi_S\iota_S\right) awN^{1-\theta}$. It follows that per capita asset holdings in the North $a^* = A^*/\ell^*$ and the South $a = A/\ell$ are constant in equilibrium. We can then use the budget constraint of the representative consumer to determine the per capita consumption expenditure levels e^* and e as functions of the variety shares and wage rates. The aggregate price level is given by $P_t = N_t^{1/(1-\varepsilon)}\left(\xi_R^*(p_R^*)^{1-\varepsilon} + \xi_R(p_R)^{1-\varepsilon} + \xi_{C_N}(p_{C_N})^{1-\varepsilon} + \xi_{C_S}(p_{C_S})^{1-\varepsilon}\right)^{1/(1-\varepsilon)}$. Let $c_t^* \equiv e_t^*/P_t$ and $c_t \equiv e_t/P_t$ denote real consumption expenditure in North and South. Following Dixit and Stiglitz (1977), this measure also represents consumers' utility at time t; we thus have $c_t^{(*)} = u_t^{(*)}$. We solve for the equilibrium utilities of North and South using (2.1):

$$u_t^* = \frac{e_t^*}{P_t} \equiv c_t^*, \quad u_t = \frac{e_t}{P_t} \equiv c_t. \tag{2.20}$$

As nominal per capita consumption expenditure $e^{(*)}$ is constant in steady state, but the aggregate price level P_t is decreasing over time, utility is growing over time. As utility is proportional to consumption expenditure when prices are held fixed it can be interpreted as real consumption growth. Thus the growth rate of utility can be interpreted as economic growth. Real consumption growth in this model is given by $\dot{u}^*/u^* = \dot{u}/u = \dot{c}^*/c^* = \dot{c}/c = g/(\varepsilon - 1) \equiv g_c > 0$. 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 the parameters of interest on welfare can be simplified to looking at changes in c_0^* and c_0.[14] As the changes in c_0^* and c_0 due to changes in IPRs are ambiguous, we leave the analysis of welfare changes in response to stronger IPR protection and different development stages of the southern research sector for the numerical analysis in this chapter.

2.5 Numerical analysis

2.5.1 Calibration of the model

Providing analytical results for the effects of chances in IPR protection on certain economic outcomes proved to be unfeasible in the previous section. In this section, to analyze the effects of changes in IPR protection on real consumption levels in both regions and the allocation of labor into the imitation of southern innovations, we calibrate the model with empirically sound parameters. The main aim of this section is not to get reliable quantitative predictions of the effects of stronger IPRs, but mainly to provide a qualitative idea about their effects on welfare, as measured in real consumption, in both regions.

To calibrate the model, parameters are set to match the following target moments[15]: The real interest rate takes a value of 7% according to the average real US stock market return

[14]This approach has been taken by Gustafsson and Segerstrom (2011).

[15]For the sake of comparability, we calibrate the target moments as in Gustafsson and Segerstrom (2011) when applicable.

over the past century estimated by Mehra and Prescott (1985). This implies a subjective discount rate ρ of the same value. Basu (1996) and Norrbin (1993) estimate a markup of 40% over marginal costs, determining the degree of differentiation between varieties α to be 0.714. The population growth rate $g_L = 0.0168$ represents the average annual world population growth rate of 1.68% between 1960-2008 reported by the World Bank World Development Indicators 2009 (World Bank, 2009). Only the ratio of population size, ℓ_0/ℓ_0^*, is relevant for the steady state equilibrium. Comparing population in middle-income to high-income coutries, this ratio is given by approximately 4.35, including low-income countries in the southern population, the ratio is about 5.27 for 2008 figures (World Bank, 2009). Due to our general notion of the South we include low-income countries and use a value of $\ell_0/\ell_0^* = 5.27$. 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), we set the value of intertemporal R&D spillovers $\theta = 0.67$. Following Gustafsson and Segerstrom (2011), we aim for a cost advantage of imitators of the South of $\eta^\star = 10\%$, leading to a parameterization of $\bar{\eta} = 0.18$ and $1/\gamma = \theta$. As only the relative research difficulty determines the steady state of the model, we set $ag = 1$ to normalize the parameters. For the benchmark case, we assume a research inefficiency of the South of $\beta = 3$, which implies a three times higher R&D labor requirement. The distance parameter for imitation d is set to 10. Given those values, we set the parameters for IPR protection to $\phi_N = \phi_S = 1.5$ which results in plausible imitation rates of about 2% of northern innovations and 9% of southern innovations.

2.5.2 Change of intellectual property rights protection for northern and southern innovations

The first simulation shows the effects of a general change in IPR protection in the South, i.e. when $\phi_N = \phi_S = \phi$. The fourth column contains the benchmark case with $\phi = 1.5$

for which the South is active in original R&D ($\ell_R > 0$) and the wage differential is such that the wide-gap case applies ($\omega < \alpha$). For lower values of ϕ up to the threshold value of about 1, no innovation takes place in the South as R&D incentives are too weak given the ease of imitating the North. Table 2.1 shows that the South loses from the strengthening of IPR protection both in terms of real consumption and relative wage until the innovation threshold is reached. This is due to the detrimental effect of IPR protection for northern varieties. The South relies on imitation of the North to obtain production blueprints. With higher protection, imitation employment leads to fewer imitation blueprints. The lower marginal productivity reduces wages and leads to an increase in production of each variety as their prices decline. Overall, employment shares do not change in the South up to the threshold. However, fewer varieties are produced in larger quantities for lower prices. Northern research declines slightly before and more noticeable after the threshold is passed.

Table 2.1: Changing IPR protection for northern and southern goods

		no innov.		with innov.		
IPR protection	$\phi_S = \phi_N$	0.6	1	1.1	1.5	2.25
relative wage S/N	ω	0.647	0.594	0.599	0.641	0.674
imitation rate N	ι_N	0.062	0.046	0.038	0.019	0.010
imitation rate S	ι_S	0	0	0.181	0.090	0.047
innov. labor N	ℓ_R^*/ℓ^*	0.214	0.205	0.201	0.185	0.176
fraction innov. labor S	ℓ_R/ℓ	0	0	0.005	0.029	0.054
fracion labor imit. N	ℓ_{C_N}/ℓ	0.164	0.164	0.134	0.053	0.023
fraction labor imit. S	$\ell_{C_S}^a/\ell$	0	0	0.008	0.027	0.030
real cons. N	c_0^*	6.028	5.989	6.222	7.488	8.865
real cons. S	c_0	4.148	3.743	3.825	4.609	5.621
rel. cons. N/S	c_0^*/c_0	1.453	1.600	1.627	1.625	1.577

Notes: [a] sum of imitators of the South and process innovators.

Figure 2.3 shows the detailed development of research employment in the South and real consumption. The change in the labor allocation in the South is comparable to the case in which only the protection of southern innovations is improved. However, the fall in imitation of the North is more pronounced as both IPR protection levels contribute to a shift from imitation of the North to research in the South.

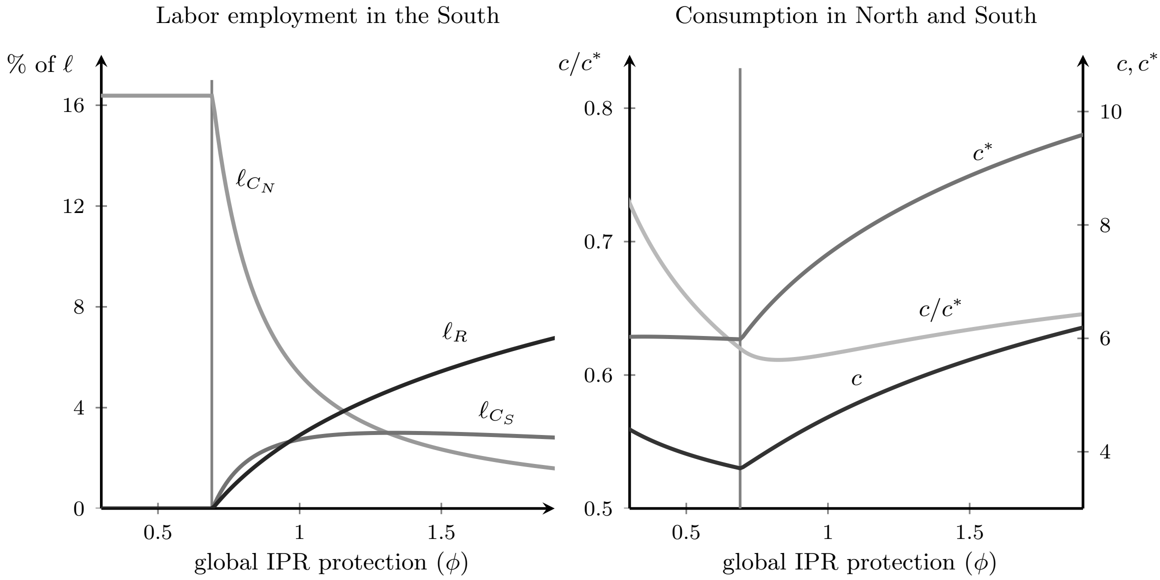

Figure 2.3: Proportionate change of IPR protection.

After an initially high imitation employment and therewith imitation rate of southern innovations, both reduce as a consequence of better protection and increased profitability of southern original R&D compared to imitation. Surprisingly, the North does not benefit from an increase in the protection of its goods before the threshold. This is due to the reduction of innovation on the one side, but more importantly due to reduced supply of lower priced imitated goods on the other side. Once the threshold is passed, both regions experience an increase in real consumption with the South starting to catch up in relative consumption.

2.5.3 Change of intellectual property rights protection for southern innovations

The simulation in table 2.2 shows the change of key variables that result from changes of the level of IPR protection for southern innovations ϕ_S only, i.e. a deviation from the national treatment principle. As the northern IPR protection level is unchanged, the threshold has slightly decreased to about $\phi_S = 0.95$. For lower values of ϕ_S, no innovation takes place in the South. As only southern IPR protection is varied, changes up to the threshold level do not affect the equilibrium. Once the threshold is passed, innovation in the South starts and new varieties developed in the South attract imitation. Thus labor employed in the imitation of southern goods first increases, but later declines steadily with the rise of IPR protection. At the same time, northern products are less frequently imitated as southern resources are shifted to innovation and imitation of the South. As more innovations stay in the North, its R&D employment decreases slightly.

Table 2.2: Changing protection of southern goods

		no innov.		with innov.		
IPR S innov.	ϕ_S	0.75	0.95	1	1.5	1.75
relative wage S/N	ω	0.555	0.555	0.563	0.641	0.660
imitation rate N	ι_N	0.036	0.036	0.033	0.019	0.017
imitation rate S	ι_S	0	0	0.237	0.090	0.069
innov. labor N	ℓ_R^*/ℓ^*	0.199	0.199	0.197	0.185	0.183
fraction innov. labor S	ℓ_R/ℓ	0	0	0.002	0.029	0.038
fracion labor imit. N	ℓ_{C_N}/ℓ	0.164	0.164	0.146	0.053	0.043
fraction labor imit. S	$\ell_{C_S}^a/\ell$	0	0	0.005	0.027	0.028
real cons. N	c_0^*	5.927	5.927	6.047	7.488	7.954
real cons. S	c_0	3.433	3.433	3.507	4.609	5.007
rel. cons. N/S	c_0^*/c_0	1.726	1.726	1.724	1.625	1.589

Notes: [a] sum of imitators of the South and process innovators.

Figure 2.4 illustrates the development of southern research employment and real consumption in greater detail. Up to the threshold level, indicated by the gray vertical bar, changes in ϕ_S remain without effect. Concerning the labor employment in the South, resources are quickly withdrawn from the imitation of the North once the threshold is passed and shifted to southern innovation and imitation of the South. While employment in imitating the South[16] initially exceeds the research employment, original research eventually becomes the largest research sector in the South. Real consumption expenditure and therewith utility are positively affected by increases in ϕ_S above the threshold level. The North benefits from higher returns to innovation as well as more product varieties provided by the South which more than compensates the higher fraction of goods supplied monopolistically. The same holds for the South, which can catch up in relative consumption to the North.

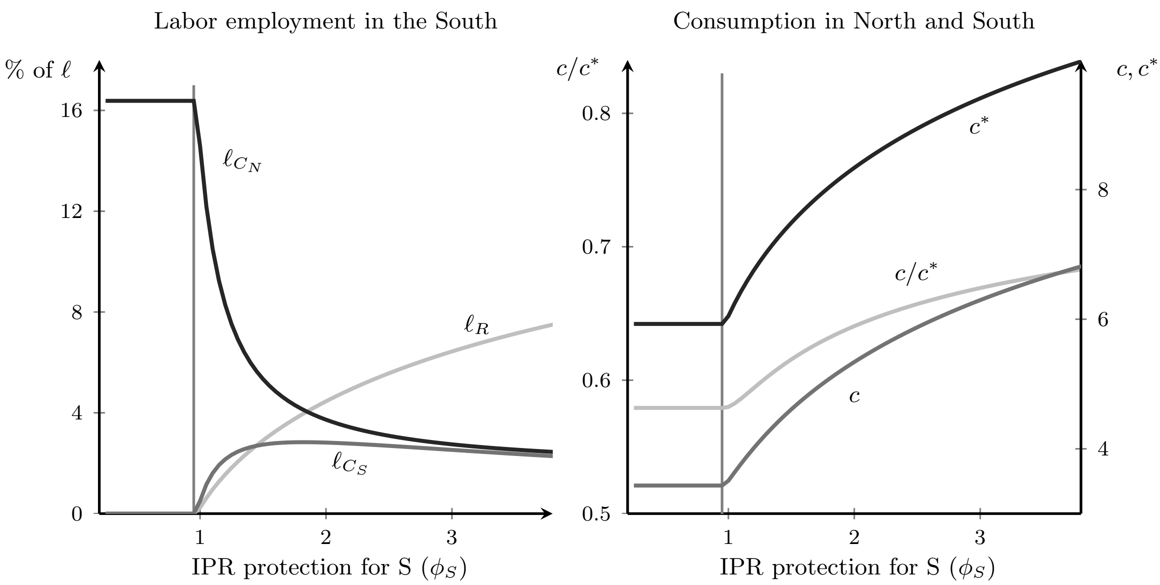

Figure 2.4: Change of protection of southern innovations.

[16]Note that ℓ_{C_S} includes both imitators and process innovators in the graphs.

2.5.4 Summary of main numerical results

The long-run consequences of a strengthening of IPRs for northern and southern innovations in the South is welfare decreasing for the South and has negligible effects for the North if the South does not engage in innovation. An increase in IPRs exclusively for southern goods is shown to have no effect on any of the regions welfare outcomes if it fails to pass the threshold level and thus fails to stimulate R&D in the South. With southern innovation, stronger IPRs for both northern and southern goods are related to higher welfare in both regions. Finally, a deviation of the South from the national treatment principle by raising IPR standards exclusively for domestic firms raises welfare in *both* regions by shifting the southern resources away from imitation to original innovation.

2.6 Concluding Remarks

This chapter gives a theoretical explanation for the empirically observed threshold level in the relationship between IPRs and innovative activity. To explain this relationship, we account for the increased R&D efforts by developing countries and extend the previous literature to allow not only for southern R&D and imitation of northern goods, but also for imitation of southern inventions. Further, to analyze the effects of southern IPR policies deviating from the national treatment principle (by raising IPRs for southern goods more strongly than for northern goods), we allow for different degrees of IPR protection for northern and southern varieties.

We show that for low levels of IPRs and low research efficiency in the South, southern R&D does not take place. The model therefore nests the results of "standard" North-South models for the no-innovation case: If IPRs are strengthened in this stage of southern development, they do not stimulate R&D and decrease wages and welfare in the South.

However, in accordance with the empirically observed patterns, we show that if IPRs surpass a critical level, they help to spur innovation in the South and increase welfare in both regions. The critical IPR level depends on the southern R&D efficiency and labor resources such that large countries or countries with a high research efficiency engage in R&D even under relatively weak protection. Likewise, to stimulate an inefficient R&D sector in a small country, IPRs have to be very strong.

We show that the protection of southern and northern innovations can work as imperfect substitutes in encouraging southern R&D though they work via different channels: While the protection of southern innovations affects expected profits from R&D directly, stronger protection of northern goods achieves this effect mainly by making the imitation of northern goods more expensive. Finally, we can show that an increase of IPRs exclusively for southern goods does not harm any region in the no-innovation case. However, if southern R&D takes place, such a policy benefits both regions by increasing the southern innovation incentives and thus shifting its resources away from the imitation of northern goods.

2.A The Model in the narrow-gap case

In this section, we describe how the model in chapter 2 changes if it is solved for an equilibrium in which the wage gap is narrow, i.e. $\omega \geq \alpha$. The main change occurs through the fact that now imitators of northern products cannot charge the monopoly price, but charge the innovator's marginal cost to exclude him from the market. Equation (2.7a) becomes

$$p_{C_N} = w^*, \quad \pi_{C_N} = (w^* - w)\bar{x}_{C_N} L. \tag{2.7a$'$}$$

From this follows that the profits used in the cost-benefit equation (2.12c) change. Accordingly, the equations which are derived with the help of this cost-benefit condition also change. These are the equations for the rate at which northern varieties are copied, the wage gap, and the equation for the employment in the southern research sector:

$$\iota_N = \frac{(1-\omega)(\rho+\theta g)g}{\frac{\gamma}{1+\gamma}\Delta_1 d\phi_N(\rho+\theta g)\omega - (1-\omega)g} \tag{2.14b$'$}$$

$$\omega^{\varepsilon-1} - \omega^{\varepsilon}\left(1 + (1-\alpha)\alpha^{\varepsilon-1}\frac{\rho+\theta g}{g}d\phi_N\right) = \frac{\gamma}{1+\gamma}\frac{d\phi_N}{\phi_S}\eta^* - (1-\alpha)\alpha^{\varepsilon-1}\frac{\rho+\theta g}{g}\frac{d\phi_N}{\beta} \tag{2.18$'$}$$

$$\ell_R = \frac{(1-\alpha)(g+\iota_S)}{\Lambda_1 + \iota_S + \frac{1-\alpha}{\eta^*}\frac{1+\gamma}{\gamma}\frac{\phi_S}{\beta}\left(\frac{\iota_S}{g}\right)^2\Lambda_2}\left(\ell - \frac{1-\alpha}{1-\omega}d\phi_N\left(\frac{\iota_N}{g}\right)^2\frac{(1-\omega)g+\omega(\rho+\theta g)}{\Lambda_1+\iota_N}\right). \tag{2.17$'$}$$

The function $f(\omega) \equiv \omega^{\varepsilon-1} - \omega^{\varepsilon}(1 + (1-\alpha)\alpha^{\varepsilon-1}\frac{\rho+\theta g}{g}d\phi_N)$ and the constant $W \equiv \frac{\gamma}{1+\gamma}\frac{d\phi_N}{\phi_S}\eta^* - (1-\alpha)\alpha^{\varepsilon-1}\frac{\rho+\theta g}{g}\frac{d\phi_N}{\beta}$ are illustrated in figure 2.5. From differentiating $f(\omega)$ follows that $df(\omega)/d\omega < 0$ if $\alpha/(1+\frac{\gamma}{1+\gamma}\Delta_1 d\phi_N(\rho+\theta g)) < \omega$. As the denominator of the expression is greater than one the relation always holds in the narrow-gap case ($\alpha \leq \omega$). Consequently, the economy is on the downward sloping side of the wage parabola.

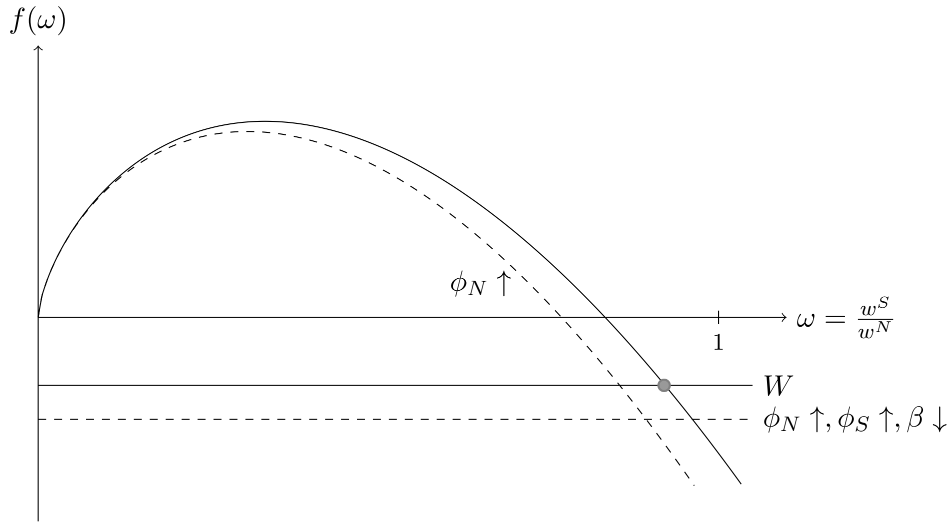

Figure 2.5: Relative wage in the narrow-gap case.

Further we know that W will be negative if the imitation rate of southern products is non-negative (compare equation (2.14a)). Figure 2.5 also illustrates the effects of changes in the southern innovation productivity β and the levels of IPR protection ϕ_N

and ϕ_S. The wage gap is higher the higher the southern disadvantage in innovation β and the lower the protection of southern goods ϕ_S: The higher β (the lower ϕ_S) the more attractive it is to imitate. When the imitation rates ι_N and ι_S rise, expected profits from innovation decline in both regions. At the same time, due to the higher imitation rates, imitation is also more costly. As a result, the southern wage declines more strongly than the northern one so that the wage gap increases. Applying the implicit function theorem to the wage function, one can see that the relative wage is falling (wage gap is rising) with stronger IPRs for northern goods ϕ_N.

While not all balanced growth path effects can be derived analytically, numerical analysis (available from the authors) showed that the remaining effects of changes in IPRs and research efficiency are qualitatively similar to the wide-gap case.

2.B The Model without southern innovation

This section describes the model for the case in which condition (2.13) is not satisfied such that southern research employment ℓ_R is not positive in the general model. As research labor cannot be negative, we set it to zero for both cases which restricts southern activity to the imitation of the North and production. In this case, $\ell_R = \ell_{C_S} = \ell_P = 0$.

The only R&D functions are (2.4a) for northern innovation and (2.5a) for southern imitation of northern goods. Likewise, the no-arbitrage conditions for southern innovation and imitation of the South drop out. The labor market clearing condition for the South becomes $\ell = \ell_{C_N} + \ell_Y = \frac{a\phi_N \iota_N}{N^\theta}\dot{n}_{C_N} + n_{C_N}\bar{x}_{C_N}L$.

Employment in the imitation sector ℓ_{C_N} is still given by (2.16), but the imitation rate in that equation is now different. Combining (2.12c) with the variety share ξ_R^*

obtained from dividing the northern R&D function by N, using $\xi_{C_N} = \iota_N \xi_R^*/g$ and substituting for ℓ_R^* from (2.15) we can solve for $n_{C_N}\bar{x}_{C_N}$. To solve for the imitation rate we substitute $n_{C_N}\bar{x}_{C_N}$ and (2.16) in the above labor-market clearing condition.[17] The resulting quadratic equations for wide- and narrow-gap case have each only one positive solution which is given by:

$$\iota_N = \frac{\ell}{\ell^*}\frac{g^2}{2\Lambda_1 d\phi_N}\left(1+\sqrt{1+\frac{4\Lambda_1 d\phi_N}{g^2}\frac{\ell^*}{\ell}}\right), \qquad \omega \leq \alpha \qquad (2.21)$$

$$\iota_N = \frac{\frac{\ell}{\ell^*}g - \Lambda_3\sqrt{(\frac{\ell}{\ell^*}g - \Lambda_3)^2 + 4\frac{\ell}{\ell^*}g\Lambda_1(d\phi_N(1-\alpha)+\alpha^{1-\varepsilon})}}{2(d\phi_N(1-\alpha)+\alpha^{1-\varepsilon})}, \qquad \omega \geq \alpha \qquad (2.21')$$

in which $\Lambda_3 = \alpha^{1-\varepsilon}(\rho+\theta g)$. The imitation rate is increasing in the relative size of the South ℓ/ℓ^* and decreasing in the level of IPR protection ϕ_N. The relative wage is calculated as

$$\omega = \left(\frac{\rho+\theta g+\iota_N}{\rho+\theta g}\frac{g}{d\phi_N\iota_N}\right)^{\frac{1}{\varepsilon}}, \qquad \omega \leq \alpha \qquad (2.22)$$

$$\omega = \frac{g(\rho+\theta g+\iota_N)\alpha^{1-\varepsilon}}{(1-\alpha)(\rho+\theta g)d\phi_N\iota_N + g(\rho+\theta g+\iota_N)\alpha^{1-\varepsilon}}, \qquad \omega \geq \alpha. \qquad (2.22')$$

As in the case with southern innovation, the relative wage between South and North is decreasing in the strength of IPR protection for northern goods. However, compared to the case in which southern innovation is possible, the imitation rate ι_N can never be zero, because imitation and the production of imitated goods constitute the only southern activities. From this fact and from (2.22′) follows that $\omega < 1$ for all parameter values.

[17]For the narrow-gap case, we additionally divide (2.12a) by (2.12c) to be able to substitute for the relative wage ω.

Consequently, the South can never catch up to the North in wages in the no-innovation case.[18]

Finally, southern asset holdings change to $A = \xi_{C_N} d\phi_N w a N^{1-\theta} \iota_N$; consumption expenditures are given by $e = \left(1 + (\rho + g_L)\frac{\xi_{C_N}}{\ell} d\phi_N a \iota_N N^{1-\theta}\right) w$ and the price index reduces to $P = N^{\frac{1}{1-\varepsilon}} \left[\xi_R^*(p_R^*)^{1-\varepsilon} + (1-\xi_R^*)(p_{C_N})^{1-\varepsilon}\right]^{1/(1-\varepsilon)}$.

[18] If innovation is possible in the South, wages in the two regions can equalize if the southern research sector catches up in efficiency. Setting $\omega = 1$ in (2.18′) we obtain the parameter combination under which wages are equal: $\Delta_1(\rho + \theta g)(1/\beta - 1) = g\eta^\star/\phi_S$. This condition says that the South can only catch up in wages if $\beta = 1$, i.e. if research in both regions is equally efficient. As northern products are not subject to imitation any longer in that case, equal wages require perfect IPR protection of southern innovations. This can be achieved by letting $\phi_S \to \infty$. Similarly $\beta = 1$ and $\eta^\star = 0$ lead to $\omega = 1$.

References

Basu, S., 1996. Procyclical productivity: increasing returns or cyclical utilization? Quarterly Journal of Economics 111 (3), 719–751.

Currie, D., Levine, P., Pearlman, J., Chui, M., 1999. Phases of imitation and innovation in a North-South endogenous growth model. Oxford Economic Papers 51 (1), 60–88.

Deardorff, A. V., 1992. Welfare Effects of Global Patent Protection. Economica 59 (233), 35–51.

Dixit, A., Stiglitz, J., 1977. Monopolistic competition and optimum product diversity. American Economic Review 67 (3), 297–308.

Eicher, T., García-Peñalosa, C., 2008. Endogenous strength of intellectual property rights: Implications for economic development and growth. European Economic Review 52 (2), 237–258.

Ginarte, J., Park, W., 1997. Determinants of patent rights: A cross-national study. Research Policy 26 (3), 283–301.

Glass, A., 2010. Imitation as a stepping stone to innovation. working paper.

Griliches, Z., Nordhaus, W., Scherer, F., 1989. Patents: Recent Trends and Puzzles. In: Winston, C., Baily, M. N. (Eds.), Brookings Papers on Economic Activity, Microeconomics 1989. pp. 291–330.

Grossman, G., Helpman, E., 1991. Endogenous Product Cycles. The Economic Journal 101 (408), 1214–1229.

Grossman, G., Lai, E., 2004. International protection of intellectual property. American Economic Review 94 (5), 1635–1653.

Gustafsson, P., Segerstrom, P., 2010. North-South trade with increasing product variety. Journal of Development Economics 92 (2), 97–106.

Gustafsson, P., Segerstrom, P., 2011. North-South trade with multinational firms and increasing product variety. International Economic Review 52 (4), 1123–1155.

Helpman, E., 1993. Innovation, imitation, and intellectual property rights. Econometrica 61 (6), 1247–1280.

Jones, C. I., 1995. R&D-based Models of Economic Growth. Journal of Political Economy 103 (4), 759–784.

Jones, C. I., 2005. Growth and ideas. In: Handbook of Economic Growth. P. Aghion and S. Durlauf, pp. 1063–1111.

Kortum, S., 1993. Equilibrium R&D and the patent–R&D ratio: US evidence. American Economic Review 83 (2), 450–457.

Kumar, N., 2003. Intellectual property rights, technology and economic development: Experiences of Asian countries. Economic and Political Weekly 38 (3), 209–226.

Mansfield, E., Schwartz, M., Wagner, S., 1981. Imitation costs and patents: an empirical study. The Economic Journal 91 (364), 907–918.

Mehra, R., Prescott, E. C., 1985. The equity premium: A puzzle. Journal of Monetary Economics 15 (2), 145–161.

Mohtadi, H., Ruediger, S., 2010. Intellectual Property Rights and Growth: Is there a Threshold Effect? Working Paper.

Newiak, M., 2011. The dual role of IPRs under imitation and innovation driven development. Working Paper.

Norrbin, S., 1993. The relation between price and marginal cost in US industry: a contradiction. Journal of Political Economy 101 (6), 1149–1164.

OECD, 2008. Science, Technology and Industry Outlook 2008.

Park, W., 2008a. International patent protection: 1960-2005. Research Policy 37 (4), 761–766.

Park, W. G., 2008b. Intellectual Property Rights and International Innovation. In: Maskus, K. E. (Ed.), Frontiers of Economics and Globalization. Intellectual Property, Growth and Trade, 2nd Edition. Elsevier, pp. 289–327.

UIS, 2009. A Global Perspective on Research and Development. UIS Fact Sheet October 2009, No. 2.

World Bank, 2009. World Development Indicators 2009.

Chapter 3

Robust FDI determinants, Intellectual Property Rights and Parameter Heterogeneity*

Abstract

We examine determinants of foreign direct investments (FDI) for developing and developed countries for a large dataset of binational FDI flows with more than 70 regressors. We particularly focus on the analysis of different intellectual property rights (IPRs) measures to explain the intensive and extensive margins of FDI. Using Heckit Bayesian Model Averaging we address both model uncertainty and the selection problem inherent in FDI data. For the global sample, we find that patent enforcement and the protection of patent rights attract FDI flows whereas trademark protection increases the probability to invest in FDI but reduces the volume. The separate analysis shows that (1) for developed countries, IPR protection in the host country has a large influence on FDI flows whereas (2) IPR protection in the source country is more relevant for investments into developing countries. This indicates that FDI flows into developed countries contain more sensitive knowledge capital and are more likely deterred by risks of leakages to competitors in the host country than FDI flows into developing countries.

Keywords: FDI determinants, Intellectual Property Rights, HeckitBMA

*This chapter is based on joint work with Theo Eicher and Monique Newiak. Walter Park and Taylor Reynolds kindly shared their data. All remaining errors are mine.

3.1 Introduction

The volume of foreign direct investment (FDI) flows has increased steeply in the last decades, reaching its peak in 2007 with almost $2 trillion or 8% of OECD countries' GDP (OECD, 2011). Looking at the sectoral distribution of FDI, 22% went into the primary sector, 48% into manufacturing and 30% to services in 2010. Within industries, the purpose of FDI also varies, from production to R&D; for instance, US worldwide R&D expenditures of affiliate firms increased from $10 billion to $35 billion between 1993 and 2007 (UNCTAD, 2010). Further, FDI flows take the form of cross-border mergers and acquisitions (M&A) or greenfield investments.

The diversity of FDI has led to the development of various theories about its motives, determinants and consequences and inspired a large body of theoretical and empirical studies. However, Blonigen (2005) points to the arising model uncertainty which causes conventional regression methods to overstate the significance of estimates (Berger and Sellke, 1987). Recent studies by Blonigen and Piger (2011) and Eicher et al. (2011a) use Bayesian Model Averaging (BMA) to juxtapose FDI theories and filter relevant determinants. BMA allows to evaluate various FDI theories in a single estimation approach such that the resulting estimates take account of model uncertainty (Raftery, 1995).

We extend this literature by introducing intellectual property rights (IPR) regressors to the analysis which are, to the best of our knowledge, not considered in any previous BMA study on FDI. The majority of theories assigns a role to IPRs in FDI decisions as it contains a transfer of knowledge from the source company to the recipient firm. This exposure entails a risk of knowledge dissipation that is of particular concern for technology-intensive firms whose competitiveness primarily derives from a technological advantage over other firms in their specific industry. Horizontal theories consider FDI as a form of foreign market entry in which production structures and distribution networks are replicated abroad (Markusen, 1984). Helpman (1984) suggests vertical FDI where technologically advanced multi-national enterprises (MNE) shift production to regions with inexpensive input factors. When production is shifted, firms have to protect their technology to maintain their competitive edge. Other studies highlight the interdependencies of imitation and FDI into developing countries and find positive effects (Gustafsson and Segerstrom, 2011) as well as negative mutual dependencies (Glass and Saggi, 2002). Trademark protection and copyrights support trade and licensing as alternative forms of market entry. The relevance of IPR variables has been confirmed by empirical studies, for instance Branstetter et al. (2007), Lee and Mansfield (1996) and Javorcik (2004b). However, these studies do not control for model uncertainty.

An additional complication in FDI studies is the often large fraction of zero observations which potentially leads to a selection bias if only non-zero observations are considered. A bias arises if the probability to observe an FDI flow depends on the same determinants as the volume of FDI. To account for the selection problem, we follow Eicher et al. (2011a) who combine the Heckman (1979) two-step estimation procedure to correct for selection bias with BMA to handle model uncertainty simultaneously in HeckitBMA. This approach allows for the analysis of the decision to invest, i.e. probability to observe an FDI flow, separately from the volume of FDI.[1]

We use a large panel of binational FDI flows with more than 7500 observations from 1988 to 2000. The data covers 20 developed and 13 developing countries with a total of 70 regressors including the patent protection measures from Park (2008) and indicators of copyright and trademark protection from Reynolds (2003). We find evidence for the

[1] This two-part decision was suggested by Razin et al. (2004) as a result from fixed costs of FDI.

relevance of IPR variables and the presence of selection bias. For the global sample, patent enforcement and protection from loss of patent rights promote the intensive margin (volume) of FDI. On the other hand, better trademark protection increases the probability of FDI but lowers the extent of FDI flows. Copyrights are not relevant for either margin. We find some evidence for vertical FDI motives as per capita income differences increase investment flows. Evidence for horizontal and export-platform FDI is mixed as regional trade agreements are irrelevant for FDI with the exception of APEC. We split the sample to consider developed and developing host countries separately and find considerable parameter heterogeneity between both country groups with a less significant role of patent protection in developing countries. This indicates that, compared to developing countries, FDI flows into developed countries contain more vulnerable knowledge capital or that the risk of imitation is more imminent for insufficient IPR protection.

3.2 Literature

FDI firms have different objectives when investing into FDI depending on whether they invest into production, distribution or R&D. Also, whether the firm uses technology-intensive production technologies and products or simple manufacturing goods affects the decision making process. This section reviews the empirical and theoretical literature on FDI, first for IPRs in particular and then in general.

3.2.1 Intellectual Property Rights and Foreign Direct Investment

Theoretical Studies

The basic theory of FDI can be related to the OLI framework (Dunning, 1988) in which incentives to engage in FDI are traced back to ownership, location and internalization advantages. As FDI exposes firms to the risk of technology diffusion from insufficient patent protection and imitation, internalization offers an advantage over licensing as firm-related knowledge is kept within the company.[2] However, internalization is not necessarily complete and depends on the IPR system in the host country. For the production of technology-intensive goods and R&D investments, IPR protection is more important than for distribution, market access and production of non-differentiated goods.

There is no consensus on the effects of IPRs on FDI in the theoretical literature. In Maskus et al. (2003), stronger IPR protection is represented by an increase in imitation costs that encourages foreign firms to invest into FDI and licensing. However, they find that the relative effects of stronger protection on licensing and FDI depend on technology: While FDI is replaced by licensing in high-innovation sectors, firms in lower-technology industries are more likely to shift from licensing to FDI as the rate of imitation in low-technology sectors is less sensitive to the level of IPR protection.

North-South models analyze FDI flows from developed to developing countries in a setup where technologically advanced countries (the North) are innovative with high domestic labor costs whereas developing countries (the South) either are not innovative at all or are less efficient in innovation. Northern firms are deterred from investments in the South by the risk of imitation due to insufficient IPR protection. In such a framework, Glass and Saggi (2002) find that if imitation in developing countries is directed towards patents of MNE (multi-national enterprises) in both regions and stronger IPR protection affects the risk of imitation proportionately, then stricter IPRs do not increase FDI but lead to a resource waste for imitators. Glass and Saggi (1998) argue that the deterring effect of imitation only applies to low-technology goods as only those are targeted by imitation.

[2]For a discussion of the OLI framework see Markusen (1995).

Contrary to these results, Gustafsson and Segerstrom (2011) restrict the South to imitate FDI goods transferred from the North to the South and find that FDI flows into the South increase unambiguously with higher IPR protection.[3] Chapter 1 (Lorenczik, 2011) allows for an innovative South that benefits from the knowledge spillovers from FDI. When IPR protection expands, FDI and southern R&D become more attractive such that the total effect on FDI depends on the level of southern development and the accessibility of the South for FDI.

Empirical Studies

Empirical studies also show ambiguous effects of stronger IPR protection. Nunnenkamp and Spatz (2004) use the aggregate Ginarte and Park (1997) index of patent protection and an alternative index by the World Economic Forum and find that stronger IPR protection increases the volume and technology level of FDI. Branstetter et al. (2007) look at IPR policy changes and find that subsequent FDI from developed to developing countries increases where technology-intensive MNE account for a larger increase than less technology-intensive firms. Lee and Mansfield (1996) find that with low levels of IPR protection in host countries, US FDI into developing countries is mainly directed to sales, distribution and simple manufacturing. Similarly for Eastern European and former Soviet countries, Javorcik (2004a) reports that more technology-intensive firms are deterred from FDI by low IPR protection and invest in distribution rather than production. Smith (2001) analyzes the joint effects of stronger IPR protection in host countries on US exports, affiliate sales and licensing. She finds that stronger IPR protection increases foreign affiliate sales and licensing in particular in countries with a strong imitative

[3] A very similar theoretical model is used in Branstetter et al. (2007).

capability. Also, higher IPRs increase the flow of knowledge to affiliate firms relative to other factor flows. Kumar (2001) studies the determinants of FDI directed to R&D activities in developing and developed host countries but does not find evidence for an impact of IPRs.

The risk of knowledge diffusion associated with FDI has been studied in connection with spillover effects from FDI.[4] For host countries, these effects can be a desired side-effect to support knowledge accumulation but are generally negative for FDI firms.[5] Empirical studies of horizontal spillover effects from FDI, i.e. whether the presence of foreign firms raises productivity of competitors in the host country, are often inconclusive.[6] Vertical linkages refer to knowledge transfers from MNE to upstream and downstream firms. Javorcik (2004b) notes that the lack of within-industry productivity effects might result from efficient internalization of knowledge transfers. However, vertical spillovers to upstream and downstream firms may be accepted by FDI firms that benefit from productivity gains by suppliers (upstream) and provide more productive input factors to customers (downstream). Javorcik uses firm-level data from Lithuania and finds evidence for positive spillover effects through backward linkages, i.e. to suppliers of FDI firms. This effect is limited, however, to subsidiaries in joint foreign and domestic ownership, not fully foreign-owned firms. Vertical upstream spillovers are also found by Kugler (2006), Bwalya (2006) and Javorcik and Spatareanu (2008).[7] Branstetter

[4]Smeets (2008) surveys this literature. He distinguishes between knowledge transfer as a purposeful diffusion of knowledge between firms and knowledge spillovers used by firms other than the firm that created the knowledge without an adequate compensation. For the purpose of this literature outline, we use the terms interchangeably.

[5]Romer (1993) notes that FDI can serve as a means to reduce the idea gap of developing economies towards developed countries.

[6]For instance, Aitken and Harrison (1999) find positive productivity effects of foreign investments for Venezuelan plant only for small plants and negative effects for domestic plants in the same sectors. An overview over the literature is given in Görg and Greenaway (2004).

[7]Javorcik and Spatareanu (2008) also find evidence for horizontal spillovers facilitated by joint projects; see also Blalock and Gertler (2008).

et al. (2006) analyze the effect of IPR reforms on US multinational firms and find a strong impact on technology transfers: R&D expenditures of affiliate firms and patent applications increase. In particular affiliates that made use of US patents already prior to reforms expand the use markedly under a stronger IPR regime.

Markusen and Trofimenko (2009) distinguish two channels of worker spillovers associated with FDI: learning by employees in foreign firms incurs lower costs than in domestic firms and offers access to new skills not available to domestic firms. For Colombian plant-level data, they show that the hiring of workers previously employed by multinationals significantly increases wages and productivity in domestic firms. Görg and Strobl (2005) find that if entrepreneurs previously worked for a multinational, their own firms have a higher productivity if it operates in the same industry. Hale and Long (2006) conduct a similar study for Chinese cities and find FDI spillovers through high-skilled worker movements for technologically advanced firms in the same city and industry. Demonstration effects from FDI result from imitation of foreign affiliates by local firms and as such occur within the same industry. Cheung and Lin (2004) analyze the effect of FDI on patent applications for inventions, utility models and external designs and find the strongest impact on external designs which is easiest to adopt from demonstration and adequate to the low level of technological development in China. Contrary to vertical spillovers, diffusion from worker mobility and demonstration are unintended leakages for FDI firms.

3.2.2 FDI motives

Markusen (1984) introduced market access in foreign countries as a motive for FDI as a result of trade frictions. In this class of models, MNE disperse into different countries where the whole production and distribution process is replicated (horizontal FDI).[8] An extension of this motive is given by export-platform models in which FDI provides access not only to the host country of FDI but also to other countries in the proximity of the host (see Blonigen et al., 2007 and Ekholm et al., 2007). This idea was already developed in Motta and Norman (1996) who find that FDI is more concentrated when trade barriers are lower as the whole region can then be served from a single FDI host. On the other hand, Helpman (1984) suggests that FDI is attracted by production cost advantages in the host country (vertical FDI). In both vertical and horizontal FDI, technologically advanced firms seek to exploit their technological advantage over local firms in the host country (technology-exploiting FDI). Markusen and Maskus (2002) combine both horizontal and vertical FDI models into a knowledge-capital model in which MNE are exporters of knowledge-based services; their empirical analysis supports the horizontal model and rejects the vertical model.[9]

Investment into FDI can also be directed to the acquisition of knowledge and technology from the host country (technology-seeking FDI) (Fosfuri and Motta, 1999, Bas and Sierra, 2002). For technology-exploiting FDI, stronger IPR protection is likely to attract FDI whereas the benefits for technology-seeking firms are inversely related to the strength of IPRs. Therefore, depending on which motive dominates, firms may prefer weaker IPR protection to take advantage from spillovers in the foreign country.

Recent studies that highlight model uncertainty for FDI are Blonigen and Piger (2011) and Eicher et al. (2011a) who use BMA to filter robust determinants of FDI flows. Eicher

[8]Markusen (1995) reviews horizontal FDI and affirms that industries whose ownership advantages consists of intangible assets such as human capital, patents and technological knowledge appreciate the internalization aspect of FDI.

[9]Knowledge-based services are managerial and engineering services, financial services, reputations and trademarks. A detailed motivation and description of the knowledge-capital model is given in Markusen (2004). A review of FDI theories is available in Saggi (2002).

et al. find mixed support for FDI theories: regional trade agreements and currency unions as indicators of horizontal FDI and export-platform theories are only robust for specific instances while market potential[10] has a negative effect on FDI. Vertical theories are not supported by their results as economic development is positively related to FDI flows. Instead, productivity, taxes and cultural similarities affect FDI flows.

3.3 Empirical Methodology

The empirical strategy follows Eicher et al. (2011a) for the estimation of HeckitBMA coefficients. This approach avoids problems of model uncertainty and selection bias which arise from the large number of candidate regressors suggested in the theory of FDI and the problem of zero or missing observations in FDI data sets. Eicher et al. (2011a) show that HeckitBMA suggests much more parsimonious models than Heckit alone. The most widely used approach to the estimation of FDI flows are gravity models in analogy to the estimation of trade flows (see Blonigen, 2005) with theoretical motivation for the application to FDI provided by Bergstrand and Egger (2007).[11] We employ the following gravity equation for our estimations

$$Y_{ijt} = \alpha_0 + \sum_{t=t_0}^{t_1-1} \alpha_t d_t + \beta_1 logGDP_{it} + \beta_2 logGDP_{jt} + \beta_3 logD_{ij} + \beta_4 X_{ijt} + \varepsilon_{ijt} \quad (3.1)$$

The gravity equation suggests that the log of binational FDI flows at time t, Y_{ijt}, depends positively on the market sizes of the source country j, GDP_{jt}, and host country i, GDP_{it},

[10] The potential of a country to function as an export platform, measured by surrounding countries' market size weighted by the distance to these countries.

[11] Other studies applying a gravity equation include, among others, Egger and Pfaffermayr (2004) and Mutti and Grubert (2004).

and negatively on the distance between the two countries, D_{ij}. A number of additional variables X_{ijt} is included in the regression to account for additional determinants derived from the theory of FDI flows. Year dummies denoted by d_t are used to capture aggregate shocks and to avoid spurious regression problems that can arise from the use of a common deflator for FDI flows.

The problem of estimating the determinants of FDI is that the data contains a large number of missing observations which, if not properly handled, leads to a selection bias that is in principle an omitted variable bias.[12] The selection problem stems from underlying, unmeasured factors that influence both whether an observation is made and the volume of FDI if the observation is available. This introduces a bias to simple OLS regressions on FDI flows. Instead, a system of regression equations is applied which models a selection equation to estimate determinants of the probability of an observation and an outcome equation to estimate the determinants of the size of an observation. FDI as a two-part decision, i.e. that the decision to invest into FDI is separate from the magnitude of the investment, is suggested by Razin et al. (2004) and derives from fixed costs involved with FDI. The system of equations is given by[13]

$$Z^* = W\gamma + u, \tag{3.2a}$$

$$Y = X\beta + \varepsilon \tag{3.2b}$$

where Z^* is a latent variable that determines whether an FDI flow Y is observed according to the observation rule $Y = Z^*$ if $Z^* > 0$ and $Y = 0$ otherwise. Whether an observation is made or, put differently, whether firms in the source country decide to invest, depends

[12] As no country pair observations are explicitly excluded from the sample, the selection problem is referred to as incidental truncation. The following description is based on Greene (2003).

[13] Subscripts are omitted for brevity whenever no risk of ambiguity arises.

on a set of regressors W which may have covariates in common with the regressors in the outcome equation, X. The selection bias arises unless (a) unobserved country characteristics that influence the selection equation are uncorrelated with the outcome equation or (b) every determinant influencing the selection equation is controlled for in the outcome equation.[14]

Under the assumption that u, ε follow a bivariate normal distribution, the regression model (3.2) can be restated using the properties of incidentally truncated bivariate normal distributions. The latent variable Z^* is replaced by the binary variable Z which takes a value of 1 if an observation is made and 0 otherwise. The system of equations is then given by[15]

$$Pr(Z = 1|W) = \Phi(W\gamma) \tag{3.3a}$$

$$Y = X\beta + \varepsilon, \text{observed only if Z=1} \tag{3.3b}$$

$$\text{where } (u, \varepsilon) \sim N[0, 0, 1, \sigma_\varepsilon, \rho]$$

The estimation follows a two-step procedure suggested by Heckman (1979) where in the first step the selection equation is estimated by a Probit regression to obtain estimates of γ. For each observation for which FDI flows are observed, the Inverse Mills Ratio (IMR) is calculated as $\hat{\lambda}(W\hat{\gamma}) = \phi(W\hat{\gamma})/\Phi(W\hat{\gamma})$, i.e. ratio of the probability density function and cumulative distribution function evaluated at the fitted values of the first stage regression. In the second step, an OLS regression of Y, which contains only observed FDI flows, on a set of regressors X including the IMR is used to estimate the coefficients

[14]The bias results from a non-zero correlation of the error terms in the outcome equation and the selection equation. As a result, the error term of the outcome equation will not have mean zero and will be correlated with the regressors (Heckman, 1976).

[15]The variance of u can be simplified to 1 without loss of generality (Wooldridge, 2002).

$\hat{\beta}$. The coefficient on the IMR, $\hat{\beta}_\lambda$, indicates whether a selection bias is present in the sample: If $\hat{\beta}_\lambda$ is significant, an OLS regression on the outcome equation (3.2b) without the IMR leads to biased β-estimates.[16] First stage and second stage regressors can share common variables; however, at least one exclusion restriction is necessary to facilitate identification.[17]

The Heckit estimation deals with the selection bias to give consistent estimates for selection and outcome equations. However, there is a large number of regressors of which subsets have been motivated by the literature on FDI. We take account of this model uncertainty by applying Bayesian Model Averaging (BMA) to the Heckit approach to filter relevant regressors. The idea is to (I) estimate the first stage selection equation (3.3a) with BMA, (II) average over fitted values to calculate the IMR for each observation which is added to the vector of second stage regressors and (III) apply linear regression BMA to all observed FDI flows to estimate (3.3b). We follow Eicher et al. (2011a) who implement BMA for the Heckit procedure to get a HeckitBMA estimation and only outline the main steps here, exemplary for stage 1: From all possible subsets of regressors $W_1, ..., W_q$, regression models $M_1, ..., M_K$ are constructed. BMA then calculates the posterior distribution of the regression coefficients γ given the data, i.e. the means and variances of the estimates, as a weighted average of the distributions of regression coefficients from regressions on all possible models M_k. The model weights depend on the model probabilities which are based on the goodness of fit of the individual models and their prior probabilities. The calculation of coefficient variances is based on an average of coefficient variances in each model and the variance of coefficient estimates across

[16] Greene (1981) establishes that the bias can be upwards or downwards.

[17] If the sets of first stage and second stage regressors are identical, the IMR can be highly collinear to the regressors such that the second stage estimation becomes very imprecise (see Leung and Yu, 1996 and Puhani, 2000).

models.[18] In both stages of HeckitBMA we use uniform priors for all models and unit information priors for parameters.[19]

Finally, the inclusion probabilities of the coefficients are derived as the sum of model probabilities of models that contain the coefficient. Posterior inclusion probabilities indicate the relevance of parameters where inclusion probabilities of less than 50% are considered as evidence against an effect; higher probabilities up to 75%, 95%, 99% or larger show weak, positive, strong or decisive evidence for an effect.[20] No inclusion probability for the coefficient on the IMR, β_λ, is calculated as it is included in all regressions. The BMA coefficients obtained in the first and second stage are consistent and robust to selection bias.[21]

3.4 Candidate Regressors

The number of different theories on FDI gives rise to a multitude of candidate regressors. The following section gives an overview over the covariates in our estimations and their anchorage in the previous literature.[22] Bergstrand and Egger (2007) introduce physical capital and a third country 'rest of the world' to the model of FDI to show that intra-industry trade and intra-industry FDI can function as complements and supply a rational

[18] For a survey of BMA and a detailed mathematical exposition see Raftery (1995). BMA as part of a two-stage estimation procedure is discussed in Viallefont et al. (2001).

[19] The unit information prior (UIP) is based on the Bayesian Information Criterion (BIC). Eicher et al. (2011b) evaluate different prior choices and find UIP to outperform other priors.

[20] This categorization was first suggested by Jeffreys (1961) and later refined by Kass and Raftery (1995).

[21] Due to computational restrictions, we use the mode oriented stochastic search (MOSS) algorithm developed by Dobra and Massam (2010) and Lenkoski and Dobra (2011) to search the model space. We use different starting points to obtain consistent results.

[22] The issue of endogeneity arises for a number of regressors. However, the problem is not addressed in this paper and left for future research. For references to studies tackling endogeneity and model uncertainty in FDI regressions see Eicher et al. (2011a), FN 13.

for the use of gravity models. Accordingly, distance and market sizes of source and host countries are used as regressors. Eicher et al. (2011a) aggregate previous studies and find that these regressors receive overwhelming support in the data.

We use separate indices to capture the effects of IPR protection. The strengths of patent enforcement and lack of restrictions on patent rights represent the actual effectiveness of patent protection in a country while membership in international patent treaties may not be closely related to the de factor level of protection. Coverage is important as countries might specifically exclude sectors from their patent laws. For instance, Kumar (2003) describes how Japan excluded chemicals and pharmaceuticals from the patent system to facilitate knowledge absorption by domestic firms until the 1970s. Trademarks and copyrights, on the other hand, are directed to the protection of trade rather than FDI and may account for substitution effects when the internalization motive of FDI becomes less important.

We use a number of economic and cultural variables that are commonly included in FDI regressions. Common Borders, language and colonial relationships account for historical ties and cultural proximity between countries and are often found to exhibit a positive influence on FDI flows.[23] In its Investing Across Borders 2010 report the World Bank constitutes that better FDI environments are associated with better governance, higher institutional quality, lower political risk and less corruption (World Bank, 2010). We use a number of country risk indicators to capture these factors.[24]

[23]See Eicher et al. (2011a) for a meta study of the empirical FDI literature.

[24]We include measures of democracy, government stability, internal and external conflict, religious and ethnic tension, presence of the military in politics, bureaucracy, rule of law and socio-economic development as measures of governance and political risk.

Real exchange rates determine the effective costs of assets and input factors in host countries. Blonigen (1997) analyzes FDI flows generated from the acquisition of firm-specific assets and finds that a depreciation supports inflow FDI as asset prices for foreign firms decrease relative to domestic firms. Froot and Stein (1991) motivate exchange rate effects with global capital market imperfections. While both find empirical support for the influence of exchange rates on FDI, other studies find no clear effects (Di Giovanni, 2005, Blonigen and Piger, 2011).

If export-platform FDI is the dominant motivation for investments, membership in regional trade agreements (RTA) by host countries increases incentives for FDI from outside the RTA as the potential of member countries to function as export-platforms increases. At the same time, an RTA can lead to a reallocation of FDI flows to a single export-platform within an RTA. This effect has been shown by Jaumotte (2004) for developing countries where FDI flows were shifted towards more developed and more stable countries within an RTA. Blomström and Kokko (1997) support export-platform motives for the bilateral trade agreement between the US and Canada where FDI within the RTA decreased while Canada received more FDI from third countries. For the European Union, Baltagi et al. (2008) find that membership leads to a divergence of FDI flows to member countries. We include all available RTA and currency unions individually to separate effects between them (see Eicher et al., 2010). A similar reasoning applies to horizontal FDI motives, amplified by tariff-jumping motives (Blonigen, 2002). Wei (2000) finds that tax rates on multinational firms in host countries lead to a reduction of inward FDI. Razin and Sadka (2006) analyze the effects of host and source taxes for a two-fold FDI decision for intensive and extensive margins of FDI and find that host taxes negatively affect the extent of FDI as well as the likelihood to invest. Source taxes are irrelevant for the magnitude of FDI but increase the likelihood to invest. Their empirical results largely support the theoretical predictions.

Depending on the motive for FDI, productivity can have different effects: If FDI is vertical, i.e. conducted to exploit technological advantages, higher productivity indicates potentially lower incentives as local competition is strong. On the other hand, if FDI is technology-seeking, high productivity indicates the potential to acquire knowledge from the host country. Razin et al. (2008) and Razin et al. (2004) assert that when positive productivity shocks occur in host countries, the volume of FDI flows is extended due to an increase in marginal profitability. At the same time, in the presence of setup costs, the likelihood to start an investment decreases.

Educational differences between host and source country of FDI can be an incentive for vertical FDI as they indicate the availability of cheap production labor and the opportunity to exploit technology advantages. This is also implied by the knowledge-capital model of FDI in which countries with scarce supply of labor profit greatly from an inflow of knowledge via FDI to utilize other factors of production (Markusen, 1997 and Markusen et al., 1996). Razin et al. (2004) find positive effects of education on FDI flows for both host and source countries, giving support to vertical and knowledge-seeking FDI motives.

Financial risks have been shown to direct investments into more secure economies. Razin et al. (2004) find that high financial security allows host countries to attract inward FDI flows while outflows are crowded out. Other economic variables are GDP growth, GDP per capita and the investment profile. GDP growth indicates favorable investment opportunities and returns to investment. In a model of corporate control, Head and Ries (2008) suggest that GDP per capita indicates higher ability on the source side of FDI which makes investments more profitable. As a measure of capital abundance, high GDP per capita indicates arbitrage opportunities between capital-abundant and labor-abundant countries (Egger and Pfaffermayr, 2004).

3.5 Data

Our data set is based on Eicher et al. (2011a) which we combine with data on intellectual property rights obtained from Park (2008) and Reynolds (2003). See table 3.3 for an overview over the data variables and sources. The updated Ginarte-Park index measures patent protection and distinguishes between patent coverage, membership in international treaties, duration, enforcement mechanisms and restrictions on patent rights, i.e. protection from loss of patent rights[25]. Each category is evaluated using a number of criteria which add up to a final score between zero for no protection and one for full protection. Out of all measures, enforcement shows the highest standard deviation between countries while protection from loss of rights is weakest on average. All measures show considerable variation with the exception of duration which is high for all regions, reflecting that patent rights are formally in place in all countries. Copyright and trademark data are obtained from Reynolds (2003). The trademark index determines the strength of protection based on coverage, procedures, i.e. enforcement and penalty mechanisms, and treaties. The copyright index aggregates scores on coverage, usage, enforcement and treaties. Both measures relate to the protection of traded goods rather than patents and capture the risk of counterfeiting. Variables for political investment risks are taken from the International Country Risk Guides 1985-2000. These measures are constructed such that higher values indicate more favorable conditions.

After combining the data by Eicher et al. (2011a) with the measures of IPRs, our unbalanced panel covers annual bilateral FDI flows from 1988 to 2000 with a total of

[25]Restrictions on patent rights is divided into (the absence of) working requirements (requirement to utilize the patented innovation), compulsory licensing and revocation of patents. We use the term protection from loss of rights in the result tables and subsequent sections.

7586 observations out of which 46% are non-zero. Zero observations occur relatively more often for developing countries. The dataset covers FDI flows for 20 developed (high-income) and 13 developing countries.[26] Table 3.2 details frequencies of observations for host and source countries. A lag FDI dummy is used as exclusion restriction where a positive coefficient indicates threshold barriers for FDI which are lower for country pairs with previous FDI flows (Razin et al., 2008).

3.6 Empirical results

3.6.1 FDI Determinants for the global sample

We first compare our results for the global sample to Eicher et al. (2011a) in table 3.4 (see appendix). The first two sets of columns show our results for the intensive margin (volume of FDI) and the extensive margin (decision to invest in FDI) for the regression system (3.3). The last two sets of columns show the equivalent results from Eicher et al. (2011a). The IMR shows evidence for the presence of a selection effect and the exclusion restriction is highly relevant for the first stage regression which ensures that selection effects are corrected for and precise estimates are obtained. For the volume of trade (second stage), we find 31 variables with evidence for an influence on FDI flows (inclusion probability >50%), most of which exhibit positive or strong evidence. Out of these regressors, patent duration, enforcement and protection from loss of rights are relevant in host and source countries; trademarks are relevant in the host of FDI only.

[26]High-income countries according to the World Bank are categorized as developed countries and middle- and low-income countries as developing countries. This gives the same country groups as the International Monetary Fund's distinction which the exception of Poland.

These results compare to 23 vital regressors in Eicher et al. with an overlap of 17 variables, i.e. most additions to the set of relevant determinants are newly added IPR variables.[27] Overlapping parameters are generally of the same sign and similar in magnitude; we see this as a confirmation of our results and the robustness of the HeckitBMA approach. The only exception is per capita income in host which shows a negative effect on the volume of FDI in our sample but is positive for Eicher et al..

From the newly added IPR variables, patent enforcement and protection from loss of rights show strong evidence for a positive impact on FDI volumes for host and source countries. Both criteria are likely the most important for investors as they reflect the effectiveness of patent protection. The positive influence of higher protection confirms the internalization purpose of FDI and the sensitivity of technology-exploiting FDI to patent rights. Patent duration is negative for host and source and might indicate a deterring effect for technology-seeking FDI. On the other hand, membership in patent treaties and coverage are not relevant for the volume of FDI. The lack of importance of membership might reflect the irrelevance of de jure protection compared to de facto protection captured by the other criteria. Out of the other IPR measures, only trademarks in the host country are relevant; their negative effect on the volume of FDI points to a substitution effect between FDI and trade.

The gravity regressors distance and market size have the expected impact on FDI as does cultural proximity represented by colonial ties and common language. Further country characteristics that positively influence binational FDI flows are the lack of corruption and low tax rates in host and source; fewer internal conflicts in host promote FDI inflows as does a higher productivity; internal conflicts increase the outflow of FDI. Other risks in

[27] Our dataset does not include a market potential variable suggested by export-platform theories. Although relevant in Eicher et al. (2011a), it is of the opposite than expected sign.

host countries determine FDI inflows but are irrelevant for the source side: the absence of religious tension, good socio-economic development, democracy and government stability advocate inflows. Unexpectedly, a better investment profile reduces FDI inflows. On the source side, higher bureaucratic quality promotes investments abroad. Regional trade agreements, with the exception of APEC, show no influence; the coefficient on bilateral trade agreements displays decisive evidence for an FDI enhancing effect. A higher real exchange rate in host countries lowers FDI volumes as expected. Estimates for per capita income indicate that FDI flows from capital-abundant into capital-scarce countries.

For the decision to invest in FDI (extensive margin, first stage), our results differ considerably from Eicher et al. (2011a). From 15 relevant variables in our results, only ethnic tension and tax in the host country show evidence in both studies. We find decisive evidence that all gravity variables matter for the investment decision while they are irrelevant in Eicher et al. Concerning intellectual property rights, only patent enforcement in the source country and trademarks are relevant while the results show evidence against patent duration, coverage, membership and copyrights for both ends of binational FDI and patent enforcement in host. With stronger trademark protection, the number of countries that receive FDI flows increases. Together with the lower FDI volumes detected in the second stage, this may represent a shift from production FDI to distribution oriented FDI which requires lower investments per host country. Good patent enforcement in the source country can be considered as a prerequisite for distributional FDI and has a positive influence on the likelihood of investments.

Colonial ties, lower corruption in source and lower taxes in host make FDI more likely. The negative effect of productivity in host supports the vertical theories of FDI. A common border reduces the propensity to invest in a foreign country, which supports export-platform and horizontal FDI theories as the market can already be served by trade relatively easily. While irrelevant once a foreign market is entered, ethnic tension shows to deter FDI from the outset.

Relating our results to the theory of FDI, we find some support for individual theories while others are partially rejected. Razin and Sadka's (2006) conjecture of a decreasing likelihood and magnitude of FDI with higher host taxes is confirmed, but source taxes reduce the volume of FDI, not the likelihood. Razin et al. (2008) predict increasing volumes of FDI but a lower likelihood to invest with higher host productivity levels, which is confirmed by our results. Between vertical and horizontal FDI motives, the results are mixed. Horizontal FDI motives are expected to rise with the introduction of regional trade agreements as they offer better distribution opportunities in the host market. We find only APEC to show such an effect on the volume of FDI. Stronger trademark protection in host countries increases the probability to invest but decrease the volume which indicates low-volume distribution FDI rather than a transfer of production. Vertical FDI motives are supported by the negative effect of per capital income in host and positive effect for source countries: development differences increase the volume of FDI (Egger and Pfaffermayr, 2004). The irrelevance of educational differences stands against the knowledge-capital model. The decisive evidence for a positive effect of patent protection supports vertical and technology-exploiting FDI motives. Patent duration reduces the volume of FDI, not the likelihood. This effect may be related to knowledge-seeking motives that are restrained by long protection periods.

Overall, the high inclusion probabilities of IPR protection variables show the relevance for FDI decisions and lend support to the theory. Previously used second stage parameters are only slightly affected. For the first stage, the results are sensitive to the new regressors and change markedly. Compared to Eicher et al. (2011a), our results support the gravity variables and the inclusion of IPR measures whereas Eicher et al. find more support for country risk characteristics as determinants of the first stage decision.

3.6.2 Developing and developed country effects

In this section, we split the sample into FDI flows that go into developing countries and those that go into developed countries to analyze differences in the effects of IPR protection. Table 3.1 shows the results for IPR measures; the first two sets of columns show the results for developed countries and the last sets of columns refer to developing countries. Variables with inclusion probabilities larger than 50% in the global sample are shaded. The second stage results for developed countries are quite similar to the global sample; trademarks in source additionally bear a negative effect on FDI while patent duration and protection from loss of rights in source become irrelevant. All other IPR variables retain their effects. The comparison with the results for developing countries reveals considerable parameter heterogeneity: Both country groups have only the negative effect of trademarks in host in common. For developing countries, stronger copyrights in the source show decisive evidence for lowering FDI; the positive effects of protection from loss of rights and patent coverage show only weak relevance with inclusion probabilities below 70%.

In general, for the volume of FDI into developed countries, IPR protection in the host plays a more important role whereas for developing countries, IPRs on the source side matter. This indicates that FDI motives vary with the FDI destination. Imitation risks and spillovers are an important factor for investments in developed countries. This could indicate that the investments are more technology intensive or that imitation capabilities are higher such that insufficient patent protection poses a significant threat to MNE. As host patent protection has no effect for FDI flows into developing countries, the knowledge transferred may not be very sophisticated and therefore not patented. Another explanation could be that the threat of imitation is not severe due to the low technology level of domestic firms in developing countries.

Table 3.1: IPRs in the split sample

	Developed Host Country						Developing Host Country					
	2nd stage (intensive margin)			1st stage (extensive margin)			2nd stage (intensive margin)			1st stage (extensive margin)		
	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev
Patent enforcement host	**1**	0.888	0.264	0.07	0.016	0.068	0.01	-0.001	0.03	0.00	0	0.013
Patent enforcement source	**1**	1.327	0.34	0.00	0	0.013	0.02	-0.009	0.123	0.03	0.015	0.096
Protect. loss of rights host	**1**	0.86	0.248	0.02	-0.004	0.039	0.01	0.004	0.16	0.01	0.003	0.032
Trademark source	**1**	-1.629	0.41	0.00	0.001	0.021	0.05	-0.037	0.294	0.14	0.144	0.393
Trademark host	**0.99**	-1.046	0.401	0.45	0.34	0.418	**1**	-4.008	1.658	0.01	-0.002	0.051
Patent duration host	**0.96**	-1.465	0.7	0.00	-0.001	0.022	0.01	0.002	0.297	0.03	0.023	0.157
Patent duration source	0.28	-0.463	0.875	0.16	0.258	0.635	0.05	-0.067	0.694	0.31	0.451	0.741
Protect. loss of rights source	0.09	0.038	0.151	**1**	-0.891	0.186	**0.68**	0.501	0.617	0.01	0.001	0.026
Member patent treaty host	0.07	0.041	0.194	0.00	0	0.013	0.01	-0.005	0.184	0.01	-0.005	0.076
Copyright source	0.05	-0.035	0.198	0.01	0.007	0.076	**1**	-2.315	3.024	0.28	0.387	0.683
Patent coverage source	0.01	0.005	0.075	**0.83**	-0.92	0.509	**0.60**	0.895	0.997	**0.74**	0.834	0.575
Member patent treaty source	0.01	-0.002	0.055	0.17	-0.181	0.427	0.02	-0.018	1.326	**1**	1.958	0.491
Copyright host	0.01	-0.001	0.045	0.02	0.011	0.086	0.02	0.014	0.437	**0.60**	-0.883	0.811
Patent coverage host	0.01	0	0.027	0.01	0.003	0.034	0.01	-0.001	0.205	**0.66**	0.693	0.574

Regressors with an inclusion probability >50% in the global sample are shaded.

None of the first stage IPR variables that showed an effect for the global sample is relevant for either country group individually. Better protection from loss of rights and patent coverage in source lower the likelihood of investments in developed host countries. This indicates that firms divert into developed countries when patent protection in the home market is insufficient. For developing host countries, weak evidence for a positive effect of patent coverage in host and source and a negative effect of better copyright protection are obtained. The only decisive effect is a positive influence of membership in patent treaties of source countries. Thus, as for the intensive margin, IPRs in source are more important in the decision to invest into FDI in developing countries than IPRs in the host country.

Table 3.5 in the appendix shows the complete results for the split dataset. For both stages and country groups, the gravity variables are relevant. Compared to the global estimation, the sets of relevant regressors are more parsimonious for the split samples. The second stage coefficients show considerable overlap with the global sample, especially for developed countries. As for the IPR variables, developing countries show substantial parameter heterogeneity compared to developed countries. Not surprisingly, a number of risk factors are not relevant for developed host countries like religious tension, external and internal conflicts, democracy and rule of law. For developing countries, a certain degree of opportunism seems to support FDI flows as military presence in politics, weak law enforcement and corruption increase FDI flows. On the other hand, better socio-economic development and fewer internal conflicts increase FDI. Interestingly, per capita income increases flows from capital-abundant to capital-scarce host countries when the host is developed but is not relevant for developing hosts.

3.7 Conclusion

The inclusion of IPR variables in a large panel of aggregate binational FDI flows shows the relevance of patent protection as well as trademark and copyright institutions for the intensive and extensive margins of FDI. Compared to the results in Eicher et al. (2011a), who use the same methodological approach but do not take account of IPR variables, HeckitBMA delivers a similar set of relevant variables for the intensive margin (volume) of FDI but results considerably differ for the extensive margin (decision to invest). For the global sample, protection from loss of patent rights and patent enforcement show clear evidence for the importance of de facto patent protection and the sensitivity of FDI firms to potential knowledge leakages. Trademark protection on both ends increases the likelihood of FDI while stronger trademarks in host countries decrease its volume, indicating a substitution effect between FDI and trade in which production is replaced by distribution networks that require a lower investment. The separate analysis of developed and developing countries shows substantial heterogeneity between the two samples. Patent protection is much more relevant for developed countries, probably due to a high technology intensity of FDI flows and better imitation capabilities in developed hosts. The weak evidence for patent right effects in developing countries indicates few concerns about the risk of imitation.

While the effects of IPR protection allow some inference on the composition of FDI and underlying motives, aggregate FDI flows are likely to combine several potentially opposing effects which impede inferences about the presence of and influence on individual FDI motives. Nevertheless, the results indicate the importance of internalization and the motive of technological-exploiting rather than technology-seeking FDI flows by the positive effects of patent protection. The irrelevance of patent rights for FDI into developing countries suggests that FDI flows do not contain crucial knowledge capital. At the same time, distribution purposes are revealed by the effects of trademark protection as are tax considerations by FDI firms. We derive some evidence for vertical FDI from the positive effect of per capita income differentials. Horizontal and export-platform theories find no convincing support. Differences between developing and developed country determinants demonstrate that a separate analysis is required to disentangle the effects on each country group.

3.A Data description and regression results

Table 3.2: Frequency table

	Source		Host	
	total	non-zero	total	non-zero
developed countries				
Australia	271	117	273	156
Austria	270	179	294	121
Belgium	312	0	316	0
Canada	278	120	289	128
Denmark	155	108	153	77
Finland	234	163	255	103
France	285	265	255	227
Greece	165	28	162	49
Ireland	289	115	297	150
Italy	250	213	251	172
Japan	308	258	278	133
Netherlands	286	239	282	178
Norway	162	78	162	64
Poland	24	11	27	18
Portugal	159	103	149	99
Spain	259	212	258	198
Sweden	249	169	292	148
Switzerland	242	198	249	111
United Kingdom	276	244	298	191
United States	281	259	271	210
developing countries				
Argentina	298	45	311	116
Brazil	223	37	232	89
Chile	267	20	270	86
Colombia	301	26	306	64
Costa Rica	155	4	154	1
Indonesia	140	13	109	31
Malaysia	258	42	256	82
Mexico	259	32	238	162
Panama	30	0	30	0
Philippines	166	19	170	57
South Africa	155	30	139	47
Turkey	303	60	290	115
Venezuela	276	46	270	70
total	7586	3453	7586	3453
developed	4755	3079	4811	2533
developing	2831	374	2775	920

Table 3.3: Regressors

Variable	Mean	Std. Dev.	Min	Max	Source
APEC	0.06	0.25	0	1	Eicher and Henn (2011)
Bilateral RTA	0.02	0.14	0	1	Eicher and Henn (2011)
Border	0.05	0.23	0	1	Eicher and Henn (2011)
Bureaucracy host	3.31	0.82	1	4	International Country Risk Guide
Bureaucracy source	3.29	0.82	1	4	International Country Risk Guide
Colony	0.04	0.20	0	1	Eicher and Henn (2011)
Common language	0.14	0.34	0	1	Razin et al. (2008)
Copyright host	0.55	0.13	0.17	0.87	Reynolds (2003)
Copyright source	0.55	0.13	0.17	0.87	Reynolds (2003)
Corruption host	4.30	1.28	1.08	6	International Country Risk Guide
Corruption source	4.27	1.27	1.08	6	International Country Risk Guide
Coverage host	0.67	0.28	0	1	Park (2008)
Coverage source	0.67	0.28	0	1	Park (2008)
Currency union dollar	0.00	0.02	0	1	Eicher and Henn (2011)
Currency union euro	0.02	0.14	0	1	Eicher and Henn (2011)
Democracy host	5.21	1.01	1	6	International Country Risk Guide
Democracy source	5.19	1.02	1	6	International Country Risk Guide
Duration host	0.92	0.12	0.50	1	Park (2008)
Duration source	0.92	0.12	0.50	1	Park (2008)
Education difference	-0.05	3.17	-8.49	8.49	Razin et al. (2008)
EEA	0.14	0.34	0	1	Eicher and Henn (2011)
EFTA	0.01	0.09	0	1	Eicher and Henn (2011)
Enforcement host	0.73	0.36	0	1	Park (2008)
Enforcement source	0.73	0.36	0	1	Park (2008)
Ethnic tension host	4.95	1.15	1	6	International Country Risk Guide
Ethnic tension source	4.93	1.16	1	6	International Country Risk Guide
EU	0.14	0.35	0	1	Eicher and Henn (2011)
External conflict host	11.17	1.13	7.50	12	International Country Risk Guide
External conflict source	11.15	1.14	7.50	12	International Country Risk Guide
Financial risk host	40.47	6.41	18	50	Razin et al. (2008)
Financial risk source	40.43	6.41	18	50	Razin et al. (2008)
GDP Growth host	0.03	0.04	-0.13	0.35	constructed from Razin et al. (2008)
GDP Growth source	0.03	0.03	-0.13	0.13	constructed from Razin et al. (2008)
Government stability host	8.08	1.95	2	11	International Country Risk Guide
Government stability source	8.09	1.94	2	11	International Country Risk Guide
Internal conflict host	10.35	2.00	3.75	12	International Country Risk Guide
Internal conflict source	10.32	2.01	3.75	12	International Country Risk Guide
Investment profile host	7.29	1.76	3	11.17	International Country Risk Guide
Investment profile source	7.29	1.75	3	11.17	International Country Risk Guide
Investment treaty	0.16	0.36	0	1	Neumayer and Spess (2005)
Lag FDI dummy	0.44	0.50	0	1	Eicher et al. (2011a)
LAIA	0.04	0.20	0	1	Eicher and Henn (2011)
Law and order host	4.90	1.34	1	6	International Country Risk Guide
Law and order source	4.88	1.34	1	6	International Country Risk Guide
Log distance	8.13	0.99	4.92	9.40	Razin et al. (2008)
Log FDI	1.81	2.61	-2.85	11.14	Razin et al. (2008)
Log GDP per capita host	9.38	1.05	6.89	10.75	constructed from RST(2008)
Log GDP per capita source	9.36	1.06	6.89	10.75	constructed from RST(2008)
Market size host	5.68	1.32	2.19	9.10	Razin et al. (2008)
Market size source	5.66	1.30	2.19	9.10	Razin et al. (2008)
Membership host	0.68	0.31	0	1	Park (2008)
Membership source	0.67	0.31	0	1	Park (2008)
Military host	5.12	1.29	1	6	International Country Risk Guide
Military source	5.10	1.30	1	6	International Country Risk Guide
NAFTA	0.01	0.08	0	1	Eicher and Henn (2011)
Negative lag FDI dummy	0.06	0.24	0	1	constructed from RST(2008)*
Protection f. loss of rights host	0.46	0.27	0	1	Park (2008)
Protection f. loss of rights source	0.46	0.28	0	1	Park (2008)
Real exchange rate	103.91	31.87	16.73	597.64	USDA http://www.ers.usda.gov
Religion host	5.34	0.94	1.50	6	International Country Risk Guide
Religion source	5.33	0.94	1.50	6	International Country Risk Guide
Socio-econ. development host	6.71	1.73	2	11	International Country Risk Guide
Socio-econ. developm. source	6.71	1.73	2	11	International Country Risk Guide
Tax host	0.22	0.11	0	0.73	1980-92: Altshuler et al. (2000); 1994-02: IRS/SOI, World Tax Database
Tax source	0.23	0.11	0	0.73	1980-92: Altshuler et al. (2000); 1994-02: IRS/SOI, World Tax Database
TFP Host	40.54	18.03	6.48	74.66	Razin et al. (2008)
TFP Source	40.31	18.21	6.48	74.66	Razin et al. (2008)
Trademark host	0.49	0.15	0.19	0.84	Reynolds (2003)
Trademark source	0.49	0.15	0.19	0.84	Reynolds (2003)

Table 3.4: Global sample

	Global						Eicher et al. (2011a)					
	2nd stage (intensive margin)			1st stage (extensive margin)			2nd stage (intensive margin)			1st stage (extensive margin)		
	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev
APEC	**1**	0.761	0.177	0.02	0.004	0.029	**1**	0.761	0.133	**0.72**	0.159	0.115
Bilateral trade agreement	**1**	0.499	0.136	0.061	0.009	0.039	0.06	0.023	0.115	0.00	0.000	0.001
Colony	**1**	1.080	0.190	**1**	0.625	0.121	**1**	1.074	0.178	0.06	0.016	0.073
Common language	**1**	0.426	0.136	0.01	0.001	0.014	**1**	0.642	0.113	**1**	-0.505	0.106
Corruption host	**1**	0.181	0.064	0.00	0.000	0.002	**0.97**	0.121	0.053	0.02	0.001	0.004
Corruption source	**1**	0.254	0.063	**0.81**	0.072	0.042	**1**	0.221	0.051	0.00	0.000	0.002
Exchange rate host/source	**1**	-0.006	0.002	0.00	0.000	0.000	0.19	0.000	0.001	0.08	0.001	0.003
Log distance	**1**	-0.733	0.052	**1**	-0.178	0.035	**1**	-0.682	0.043	0.12	0.015	0.044
Market size host	**1**	1.031	0.054	**1**	0.257	0.028	**1**	-1.036	0.124	0.02	0.001	0.005
Market size source	**1**	0.969	0.055	**1**	0.263	0.034	**1**	0.543	0.124	0.01	0.000	0.004
Negative lag FDI dummy	**1**	-0.374	0.122	**1**	0.668	0.102	**0.99**	-0.296	0.119	0.00	0.000	0.001
p.c. income host	**1**	-1.424	0.171	0.01	-0.001	0.009	**1**	1.016	0.042	**1**	0.505	0.099
Patent duration host	**1**	-1.805	0.551	0.26	0.223	0.405	.	.	.	.	.	.
Patent duration source	**1**	-1.832	0.638	0.00	0.000	0.014	.	.	.	.	.	.
Patent enforcement source	**1**	0.755	0.249	**0.90**	0.312	0.140	.	.	.	.	.	.
Protect. loss of rights source	**1**	0.919	0.212	0.02	-0.003	0.027	.	.	.	.	.	.
Religious tension host	**1**	0.190	0.066	0.01	0.000	0.005	**1**	0.284	0.054	**1**	0.249	0.019
Socioeconomic dev. host	**1**	0.123	0.042	0.17	0.008	0.020	0.14	0.006	0.020	0.00	0.001	0.044
Tax host	**1**	-5.196	0.512	**0.71**	-0.706	0.512	**1**	-4.636	0.435	**1**	-0.201	0.025
Tax source	**1**	-4.992	0.509	0.17	-0.115	0.280	**1**	-4.462	0.446	**1**	0.244	0.026
TFP host	**1**	0.052	0.008	**0.68**	-0.005	0.004	**1**	0.040	0.006	0.01	0.000	0.004
Trademark host	**1**	-1.260	0.368	**0.75**	0.588	0.390	.	.	.	.	.	.
p.c. income source	**0.99**	0.562	0.185	0.01	0.002	0.026	**1**	0.824	0.044	0.01	0.000	0.005
Investment profile host	**0.99**	-0.132	0.049	0.00	0.000	0.002	0.02	-0.001	0.007	0.01	0.000	0.003
Internal conflict source	**0.99**	-0.112	0.044	0.00	0.000	0.001	0.16	-0.010	0.029	0.01	0.000	0.001
Democracy host	**0.98**	0.177	0.074	0.03	0.002	0.012	0.02	0.001	0.009	0.01	0.000	0.002
Patent enforcement host	**0.97**	0.442	0.196	0.00	0.000	0.007	.	.	.	.	.	.
Protect. loss of rights host	**0.94**	0.425	0.220	0.19	-0.065	0.147	.	.	.	.	.	.
Bureaucracy source	**0.90**	0.277	0.160	0.00	0.000	0.004	**0.79**	0.188	0.140	0.01	0.000	0.001
Internal conflict host	**0.79**	0.066	0.048	0.01	0.000	0.002	**0.98**	0.089	0.037	0.02	0.005	0.046
Government stability host	**0.72**	0.058	0.049	0.00	0.000	0.001	0.05	0.002	0.011	0.00	0.000	0.001
Religious tension source	0.44	-0.066	0.091	0.03	-0.002	0.013	0.01	0.000	0.006	**0.99**	-0.011	0.003
TFP source	0.41	0.005	0.008	0.03	0.000	0.001	0.08	0.001	0.003	0.01	0.003	0.051
Growth host	0.37	1.005	1.598	0.01	0.004	0.071	**1**	3.073	1.071	0.00	-0.001	0.030
Socioeconomic dev. source	0.20	0.013	0.031	0.01	0.000	0.004	0.06	0.004	0.017	0.01	0.000	0.001
External conflict source	0.12	-0.010	0.032	0.00	0.000	0.002	0.01	0.000	0.003	0.09	-0.040	0.140
Same RTA	0.07	0.030	0.135	0.05	0.017	0.080	0.03	0.004	0.033	0.00	0.000	0.001
LAIA	0.06	-0.037	0.180	0.00	0.000	0.008	**0.98**	-1.113	0.490	0.01	0.000	0.008
Democracy source	0.06	0.007	0.034	0.00	0.000	0.003	0.03	0.002	0.016	0.01	0.000	0.002
Growth source	0.04	0.095	0.599	0.01	0.007	0.109	0.01	0.004	0.145	0.00	0.000	0.000
Trademark source	0.03	-0.014	0.097	**1**	0.997	0.211	.	.	.	.	.	.
Ethnic tension host	0.02	0.001	0.011	**1**	0.097	0.025	0.01	0.000	0.004	**0.68**	0.030	0.023
Copyright source	0.02	-0.007	0.078	0.05	0.029	0.133	.	.	.	.	.	.
Patent coverage host	0.02	-0.004	0.052	0.04	0.012	0.065	.	.	.	.	.	.
Copyright host	0.01	0.005	0.064	0.30	-0.208	0.348	.	.	.	.	.	.
External conflict host	0.01	-0.001	0.009	0.01	0.000	0.005	0.02	0.000	0.006	0.00	0.000	0.002
Military source	0.01	-0.001	0.013	0.01	0.000	0.005	0.02	-0.001	0.013	0.28	0.043	0.073
Education diff. (source to host)	0.01	0.000	0.003	0.01	0.000	0.002	0.02	0.000	0.003	0.02	0.001	0.006
Government stability source	0.01	0.000	0.005	0.00	0.000	0.001	0.02	0.000	0.006	0.01	0.000	0.009
EEA	0.01	0.001	0.019	0.00	0.000	0.009	0.01	0.000	0.014	0.29	-0.001	0.002
Financial risk host	0.01	0.000	0.001	0.00	0.000	0.000	0.01	0.000	0.001	**0.83**	0.058	0.032
Currency €	0.01	0.002	0.030	0.00	0.000	0.010	0.01	0.001	0.026	0.00	0.000	0.001
Financial Risk Source	0.01	0.000	0.002	0.00	0.000	0.001	0.01	0.000	0.001	**1**	0.409	0.054
Law source	0.01	0.000	0.009	0.10	0.009	0.029	0.01	0.000	0.008	0.13	-0.009	0.025
Law host	0.01	0.000	0.007	0.02	0.001	0.008	0.46	0.052	0.071	0.01	0.000	0.003
Membership patent treaty host	0.01	-0.002	0.039	0.01	-0.002	0.032	.	.	.	.	.	.
Membership patent treaty source	0.01	0.002	0.041	0.00	0.000	0.011	.	.	.	.	.	.
Investment profile source	0.01	0.000	0.003	0.02	-0.001	0.006	**0.96**	0.076	0.035	0.10	0.004	0.014
Military host	0.01	0.000	0.006	0.01	0.000	0.003	0.01	0.000	0.005	**0.65**	-0.401	0.331
EFTA	0.01	0.001	0.029	0.00	0.000	0.013	0.01	-0.001	0.028	**1**	0.836	0.078
NAFTA	0.01	-0.001	0.033	0.01	0.004	0.055	0.01	0.003	0.050	0.00	0.001	0.025
Border	0.01	0.000	0.014	**1**	-0.608	0.130	0.02	0.003	0.032	0.01	-0.002	0.024
Bureaucracy host	0.01	0.000	0.008	0.02	-0.001	0.012	0.03	0.003	0.023	0.01	0.000	0.003
Patent coverage source	0.01	0.000	0.024	0.02	0.007	0.051	.	.	.	.	.	.
Ethnic tension source	0.01	0.000	0.004	**1**	0.100	0.023	**0.92**	0.090	0.051	0.00	0.000	0.011
EU	0.01	0.000	0.010	0.02	-0.003	0.027	0.01	0.000	0.010	0.01	0.000	0.002
Currency $	0.00	.	.	0.00	-0.019	76.115	**1**	4.434	1.194	0.05	0.003	0.012
Market potential	.	.	.	.	.	.	**0.93**	-0.433	0.235	0.00	0.000	0.004
Lag FDI dummy (excl. restr.)				**1**	2.365	0.053				**1**	2.241	0.038
IMR[a]		-0.371	0.099					-0.33	0.085			
BIC		-3236.626						-27581.85				
N		3453			7586			5329			14462	

[a] In the 2nd stage the IMR is always included. The exclusion restriction is only included in the 1st stage. Year dummies were included in the estimation and have an inclusion probability of 1, they are omitted from the table.

Table 3.5: Split sample

	Developed Host Country						Developing Host Country					
	2nd stage (intensive margin)			1st stage (extensive margin)			2nd stage (intensive margin)			1st stage (extensive margin)		
	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev	incl. prob.	post. mean	post. stdev
APEC	**1**	0.862	0.221	0.01	0.002	0.023	0.01	0.001	0.205	0.01	0.001	0.023
Colony	**1**	0.912	0.227	0.02	0.004	0.036	**1**	1.059	0.401	**1**	1.71	0.349
Common language	**1**	0.408	0.151	0.01	0.002	0.02	**1**	1.045	0.353	0.01	0.001	0.018
Corruption host	**1**	0.235	0.064	**0.92**	0.169	0.062	**0.91**	-0.222	0.303	0.02	-0.001	0.014
Corruption source	**1**	0.264	0.076	0.50	0.061	0.067	**1**	0.291	0.321	**0.67**	0.135	0.109
External conflict host	**1**	-0.154	0.058	0.00	0	0.002	0.01	0	0.01	0.01	0	0.005
Internal conflict source	**1**	0.225	0.059	0.01	0	0.005	0.05	-0.005	0.048	0.01	-0.001	0.009
Log distance	**1**	-0.759	0.057	**1**	-0.169	0.044	**1**	-1.141	1.731	**1**	-0.459	0.098
Market sizehost	**1**	0.945	0.057	**1**	0.256	0.041	**1**	1.37	0.376	**1**	0.409	0.063
Market size source	**1**	1.045	0.066	**1**	0.428	0.055	**1**	0.844	0.264	**1**	0.58	0.083
Negative lag FDI dummy	**1**	-0.404	0.136	**1**	0.758	0.123	0.01	-0.001	0.022	0.14	0.063	0.17
p.c. income host	**1**	-1.622	0.225	**0.85**	-0.4	0.209	0.01	0.003	0.103	0.02	-0.004	0.032
p.c. income source	**1**	0.671	0.133	0.17	0.074	0.176	0.01	-0.001	0.092	0.02	0.004	0.038
Patent enforcement host	**1**	0.888	0.264	0.07	0.016	0.068	0.01	-0.001	0.03	0.00	0	0.013
Patent enforcement source	**1**	1.327	0.34	0.00	0	0.013	0.02	-0.009	0.123	0.03	0.015	0.096
Protect. loss of rights host	**1**	0.86	0.248	0.02	-0.004	0.039	0.01	0.004	0.16	0.01	0.003	0.032
Tax host	**1**	-4.625	0.559	0.01	-0.006	0.07	0.01	-0.005	0.417	0.01	-0.006	0.084
Tax source	**1**	-6.139	0.608	**1**	-2.092	0.389	**1**	-7.474	1.142	0.14	-0.173	0.475
TFP host	**1**	0.044	0.011	0.18	-0.003	0.007	**1**	-0.036	0.021	0.35	-0.009	0.014
Trademark source	**1**	-1.629	0.41	0.00	0.001	0.021	0.05	-0.037	0.294	0.14	0.144	0.393
Trademark host	**0.99**	-1.046	0.401	0.45	0.34	0.418	**1**	-4.008	1.658	0.01	-0.002	0.051
Democracy source	**0.98**	0.312	0.133	0.01	0	0.008	0.02	0.003	0.043	0.01	0	0.009
Patent duration host	**0.96**	-1.465	0.7	0.00	-0.001	0.022	0.01	0.002	0.297	0.03	0.023	0.157
External conflict source	**0.92**	-0.142	0.076	0.06	0.007	0.029	0.01	0.001	0.014	0.00	0	0.003
Growth source	**0.77**	5.732	4.181	0.02	0.08	0.631	0.01	-0.018	0.673	0.02	-0.048	0.455
Patent duration source	0.28	-0.463	0.875	0.16	0.258	0.635	0.05	-0.067	0.694	0.31	0.451	0.741
Investment profile source	0.17	-0.013	0.037	0.27	-0.024	0.044	0.01	0.001	0.012	**0.78**	-0.114	0.072
Bureaucracy host	0.16	0.037	0.105	0.00	0	0.003	0.01	-0.001	0.017	0.22	-0.047	0.097
Religious tension host	0.14	-0.018	0.055	0.01	0	0.005	0.01	0.001	0.026	0.05	0.007	0.033
Ethnic tension source	0.12	0.012	0.04	**1**	0.215	0.037	0.01	0	0.098	**1**	0.245	0.051
Military host	0.11	-0.014	0.049	0.00	0	0.002	0.01	0	0.017	0.01	0	0.005
Military source	0.11	0.028	0.1	0.05	-0.016	0.077	**0.95**	-0.462	0.285	**1**	-0.381	0.091
Same RTA	0.09	0.067	0.259	0.03	0.015	0.088	0.02	-0.006	0.174	0.00	0	0.015
Protect. loss of rights source	0.09	0.038	0.151	**1**	-0.891	0.186	**0.68**	0.501	0.617	0.01	0.001	0.026
Membership patent treaty host	0.07	0.041	0.194	0.00	0	0.013	0.01	-0.005	0.184	0.01	-0.005	0.076
NAFTA	0.07	-0.041	0.196	0.00	0.001	0.032	0.01	0.002	1.547	0.02	0.078	155.676
Copyright source	0.05	-0.035	0.198	0.01	0.007	0.076	**1**	-2.315	3.024	0.28	0.387	0.683
TFP source	0.05	0	0.003	0.16	-0.003	0.007	0.15	-0.003	0.008	0.01	0	0.002
Growth host	0.04	0.103	0.635	0.09	0.19	0.684	0.08	-0.213	0.878	0.00	0	0.042
Socioeconomic dev. source	0.03	0.003	0.02	0.10	0.011	0.035	**1**	0.214	0.077	**1**	0.228	0.06
Socioeconomic dev. host	0.03	0.001	0.01	0.01	0	0.003	**0.94**	0.126	0.106	0.00	0	0.002
Currency €	0.02	0.005	0.051	0.00	0	0.011	.	.	.	.	.	.
Democracy host	0.02	0.002	0.017	0.01	0	0.004	0.01	0	0.013	0.00	0	0.003
EEA	0.02	0.002	0.026	0.01	0.002	0.025	.	.	.	.	.	.
Patent coverage source	0.01	0.005	0.075	**0.83**	-0.92	0.509	**0.60**	0.895	0.997	**0.74**	0.834	0.575
Law host	0.01	-0.001	0.013	0.04	0.003	0.015	**1**	-0.25	0.461	0.01	0	0.006
Education diff. (source to host)	0.01	0	0.005	0.00	0	0.001	0.01	0	0.004	**0.99**	-0.137	0.043
Exchange rate host/source	0.01	0	0	0.00	0	0	**1**	-0.007	0.002	0.02	0	0
Border	0.01	0.002	0.028	0.07	-0.022	0.091	0.09	-0.088	1.369	**1**	-1.806	0.44
Internal conflict host	0.01	0	0.006	0.00	0	0.002	**1**	0.265	0.287	0.00	0	0.002
EFTA	0.01	0.002	0.038	0.00	0	0.015	.	.	.	.	.	.
Law source	0.01	0	0.012	0.01	0	0.006	0.17	-0.046	0.122	0.22	0.045	0.091
EU	0.01	0.001	0.014	0.01	-0.001	0.017	.	.	.	.	.	.
Bureaucracy source	0.01	0.001	0.026	0.01	0	0.014	0.02	0.004	0.042	0.00	0	0.01
Membership patent treaty source	0.01	-0.002	0.055	0.17	-0.181	0.427	0.02	-0.018	1.326	**1**	1.958	0.491
Copyright host	0.01	-0.001	0.045	0.02	0.011	0.086	0.02	0.014	0.437	**0.60**	-0.883	0.811
Bilateral trade agreement	0.01	0.001	0.021	0.01	0	0.01	**0.56**	0.171	0.4	0.00	0	0.008
Government stability source	0.01	0	0.005	0.02	-0.001	0.009	0.07	0.006	0.03	0.01	0	0.004
Ethnic tension host	0.01	0	0.005	0.18	0.012	0.029	0.48	0.061	0.177	0.01	0	0.006
Religious tension source	0.01	0	0.011	0.01	0	0.007	0.02	0.004	0.05	0.00	0	0.006
Government stability host	0.01	0	0.003	0.00	0	0.001	0.01	0	0.007	0.00	0	0.003
Financial risk host	0.01	0	0.001	0.01	0	0.002	0.02	0.001	0.01	0.01	0	0.002
Patent coverage host	0.01	0	0.027	0.01	0.003	0.034	0.01	-0.001	0.205	**0.66**	0.693	0.574
Investment profile host	0.01	0	0.003	0.00	0	0.002	0.04	-0.003	0.029	0.00	0	0.002
Financial risk source	0.01	0	0.001	0.01	0	0.001	**0.90**	0.048	0.03	0.01	0	0.002
Currency $	0.01	.	.	0.00	-0.013	93.246	0.01	.	.	0.00	-0.017	97.825
LAIA	.	.	.	.	.	.	**1**	-2.522	1.031	0.00	0	0.012
lag FDI dummy (excl. restr.)				**1**	2.388	0.068				**1**	1.947	0.102
IMR[a]		-0.289	0.128					-0.451	0.344			
BIC		-2428.509						-798.934				
N		2533			4811			920			2775	

[a] In the 2nd stage the IMR is always included. The exclusion restriction is only included in the 1st stage. Year dummies were included in the estimation and have an inclusion probability of 1, they are omitted from the table. Regressors with an inclusion probability >50% in the global sample are shaded.

References

Aitken, B., Harrison, A., 1999. Do domestic firms benefit from direct foreign investment? evidence from Venezuela. American Economic Review 89 (3), 605–618.

Altshuler, R., Grubert, H., Newlon, T. S., 2000. Has U.S. investment abroad become more sensitive to tax rates? In: Hines, J. (Ed.), International Taxation and Multinational Activity. University of Chicago Press, pp. 9–38.

Baltagi, B., Egger, P., Pfaffermayr, M., 2008. Estimating regional trade agreement effects on FDI in an interdependent world. Journal of Econometrics 145 (1-2), 194–208.

Bas, C., Sierra, C., 2002. 'Location versus home country advantages' in R&D activities: some further results on multinationals' locational strategies. Research Policy 31 (4), 589–609.

Berger, J., Sellke, T., 1987. Testing a point null hypothesis: the irreconcilability of p values and evidence. Journal of the American Statistical Association 82 (397), 112–122.

Bergstrand, J., Egger, P., 2007. A knowledge-and-physical-capital model of international trade flows, foreign direct investment, and multinational enterprises. Journal of International Economics 73 (2), 278–308.

Blalock, G., Gertler, P., 2008. Welfare gains from foreign direct investment through technology transfer to local suppliers. Journal of International Economics 74 (2), 402–421.

Blomström, M., Kokko, A., 1997. Regional integration and foreign direct investment: A conceptual framework and three cases. Policy Research Working Paper 1740.

Blonigen, B., 1997. Firm-specific assets and the link between exchange rates and foreign direct investment. American Economic Review 87 (3), 447–465.

Blonigen, B., 2002. Tariff-jumping antidumping duties. Journal of International Economics 57 (1), 31.

Blonigen, B., 2005. A review of the empirical literature on FDI determinants. Atlantic Economic Journal 33, 383–403.

Blonigen, B., Davies, R., Waddell, G., Naughton, H., 2007. FDI in space: Spatial autoregressive relationships in foreign direct investment. European Economic Review 51 (5), 1303–1325.

Blonigen, B., Piger, J., 2011. Determinants of foreign direct investment. NBER Working Papers Working Paper 16704.

Branstetter, L., Fisman, R., Foley, C., Saggi, K., 2007. Intellectual property rights, imitation, and foreign direct investment: Theory and evidence. National Bureau of Economic Research NBER Working Paper 13033.

Branstetter, L. G., Fisman, R., Foley, C. F., 2006. Do stronger intellectual property rights increase international technology transfer? empirical evidence from U.S. firm-level panel data. Quarterly Journal of Economics 121 (1), 321–349.

Bwalya, S., 2006. Foreign direct investment and technology spillovers: Evidence from panel data analysis of manufacturing firms in Zambia. Journal of Development Economics 81 (2), 514–526.

Cheung, K., Lin, P., 2004. Spillover effects of FDI on innovation in China: Evidence from the provincial data. China Economic Review 15 (1), 25–44.

Di Giovanni, J., 2005. What drives capital flows? the case of cross-border M&A activity and financial deepening. Journal of International Economics 65 (1), 127–149.

Dobra, A., Massam, H., 2010. The mode oriented stochastic search (MOSS) algorithm for log-linear models with conjugate priors. Statistical Methodology 7 (3), 240–253.

Dunning, J., 1988. The eclectic paradigm of international production: a restatement and some possible extensions. Journal of International Business Studies 19 (1), 1–31.

Egger, P., Pfaffermayr, M., 2004. Foreign direct investment and European integration in the 1990s. The World Economy 27 (1), 99–110.

Eicher, T., Helfman, L., Lenkoski, A., 2011a. Robust FDI determinants: Bayesian Model Averaging in the presence of selection bias. working paper.

Eicher, T., Henn, C., 2011. One money, one market: A revised benchmark. Review of International Economics 19 (3), 419–435.

Eicher, T., Henn, C., Papageorgiou, C., 2010. Trade creation and diversion revisited: accounting for model uncertainty and natural trading partner effects. Journal of Applied Econometrics.

Eicher, T., Papageorgiou, C., Raftery, A., 2011b. Default priors and predictive performance in bayesian model averaging, with application to growth determinants. Journal of Applied Econometrics 26 (1), 30–55.

Ekholm, K., Forslid, R., Markusen, J., 2007. Export-platform foreign direct investment. Journal of the European Economic Association 5 (4), 776–795.

Fosfuri, A., Motta, M., 1999. Multinationals without advantages. The Scandinavian Journal of Economics 101 (4), 617–630.

Froot, K., Stein, J., 1991. Exchange rates and foreign direct investment: an imperfect capital markets approach. Quarterly Journal of Economics 106 (4), 1191.

Ginarte, J., Park, W., 1997. Determinants of patent rights: A cross-national study. Research Policy 26 (3), 283–301.

Glass, A., Saggi, K., 1998. International technology transfer and the technology gap. Journal of Development Economics 55 (2), 369–398.

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

Görg, H., Greenaway, D., 2004. Much ado about nothing? Do domestic firms really benefit from foreign direct investment? The World Bank Research Observer 19 (2), 171–197.

Görg, H., Strobl, E., 2005. Spillovers from foreign firms through worker mobility: An empirical investigation. The Scandinavian Journal of Economics 107 (4), 693–709.

Greene, W., 1981. Sample selection bias as a specification error: A comment. Econometrica 49 (3), 795–798.

Greene, W., 2003. Econometric analysis, 5th Edition. Prentice Hall Upper Saddle River, NJ.

Gustafsson, P., Segerstrom, P. S., 2011. North-South trade with multinational firms and increasing product variety. International Economic Review 52 (4), 1123–1155.

Hale, G., Long, C., 2006. What determines technological spillovers of foreign direct investment: Evidence from China. Yale Economic Growth Center Discussion Paper 934.

Head, K., Ries, J., 2008. FDI as an outcome of the market for corporate control: Theory and evidence. Journal of International Economics 74 (1), 2–20.

Heckman, J., 1976. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. Annals of Economic and Social Measurement 5 (4), 120–137.

Heckman, J., 1979. Sample selection bias as a specification error. Econometrica 47 (1), 153–161.

Helpman, E., 1984. A simple theory of international trade with multinational corporations. Journal of Political Economy 92 (3), 451–471.

Jaumotte, F., 2004. Foreign direct investment and regional trade agreements: The market size effect revisited. International Monetary Fund WP/04/206.

Javorcik, B., 2004a. The composition of foreign direct investment and protection of intellectual property rights: Evidence from transition economies. European Economic Review 48 (1), 39–62.

Javorcik, B., 2004b. Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. American Economic Review 94 (3), 605–627.

Javorcik, B., Spatareanu, M., 2008. To share or not to share: Does local participation matter for spillovers from foreign direct investment? Journal of Development Economics 85 (1-2), 194–217.

Jeffreys, H., 1961. Theory of Probability. Oxford University Press.

Kass, R., Raftery, A., 1995. Bayes factors. Journal of the American Statistical Association 90 (430), 773–795.

Kugler, M., 2006. Spillovers from foreign direct investment: Within or between industries? Journal of Development Economics 80 (2), 444–477.

Kumar, N., 2001. Determinants of location of overseas R&D activity of multinational enterprises: The case of US and Japanese corporations. Research Policy 30 (1), 159–174.

Kumar, N., 2003. Intellectual property rights, technology and economic development: Experiences of Asian countries. Economic and Political Weekly 38 (3), 209–226.

Lee, J., Mansfield, E., 1996. Intellectual property protection and US foreign direct investment. Review of Economics and Statistics 78 (2), 181–186.

Lenkoski, A., Dobra, A., 2011. Computational aspects related to inference in Gaussian graphical models with the G-wishart prior. Journal of Computational and Graphical Statistics 20 (1), 140–157.

Leung, S., Yu, S., 1996. On the choice between sample selection and two-part models. Journal of Econometrics 72 (1), 197–229.

Lorenczik, C., 2011. Intellectual property rights as determinant of FDI, technology spillovers and R&D in developing economies. working paper.

Markusen, J., 1984. Multinationals, multi-plant economies, and the gains from trade. Journal of International Economics 16 (3-4), 205–226.

Markusen, J., 1995. The boundaries of multinational enterprises and the theory of international trade. Journal of Economic Perspectives 9 (2), 169–189.

Markusen, J., 1997. Trade versus investment liberalization. National Bureau of Economic Research NBER Working Paper 6231.

Markusen, J., 2004. Multinational firms and the theory of international trade. The MIT Press.

Markusen, J., Maskus, K., 2002. Discriminating among alternative theories of the multinational enterprise. Review of International Economics 10 (4), 694–707.

Markusen, J., Trofimenko, N., 2009. Teaching locals new tricks: Foreign experts as a channel of knowledge transfers. Journal of Development Economics 88 (1), 120–131.

Markusen, J., Venables, A., Konan, D., Zhang, K., 1996. A unified treatment of horizontal direct investment, vertical direct investment, and the pattern of trade in goods and services. National Bureau of Economic Research NBER Working Paper 5696.

Maskus, K., Saggi, K., Puttitanum, T., 2003. Patent rights and international technology transfer through direct investment and licensing. Prepared for the conference "International Public Goods and the Transfer of Technology after TRIPS", Duke Law School, April 4-6, 2003.

Motta, M., Norman, G., 1996. Does economic integration cause foreign direct investment? International Economic Review 37 (4), 757–83.

Mutti, J., Grubert, H., 2004. Empirical asymmetries in foreign direct investment and taxation. Journal of International Economics 62 (2), 337–358.

Neumayer, E., Spess, L., 2005. Do bilateral investment treaties increase foreign direct investment to developing countries? World development 33 (10), 1567–1585.

Nunnenkamp, P., Spatz, J., 2004. Intellectual property rights and foreign direct investment: A disaggregated analysis. Review of World Economics 140 (3), 393–414.

OECD, 2011. Foreign direct investment (FDI) statistics - OECD data.

Park, W., 2008. International patent protection: 1960–2005. Research Policy 37 (4), 761–766.

Puhani, P., 2000. The Heckman correction for sample selection and its critique. Journal of Economic Surveys 14 (1), 53–68.

Raftery, A., 1995. Bayesian model selection in social research. Sociological Methodology 25, 111–164.

Razin, A., Rubinstein, Y., Sadka, E., 2004. Fixed costs and FDI: The conflicting effects of productivity shocks. National Bureau of Economic Research NBER Working Paper No. 10864.

Razin, A., Sadka, E., 2006. Vying for foreign direct investment: A EU-type model of tax competition. National Bureau of Economic Research NBER Working Paper 11991.

Razin, A., Sadka, E., Tong, H., 2008. Bilateral FDI flows: Threshold barriers and productivity shocks. CESifo Economic Studies 54 (3), 451.

Reynolds, T., 2003. Quantifying the evolution of copyright and trademark law. Ph.D. thesis.

Romer, P., 1993. Idea gaps and object gaps in economic development. Journal of Monetary Economics 32 (3), 543–573.

Saggi, K., 2002. Trade, foreign direct investment, and international technology transfer: A survey. The World Bank Research Observer 17 (2), 191–235.

Smeets, R., 2008. Collecting the pieces of the FDI knowledge spillovers puzzle. The World Bank Research Observer 23 (2), 107–138.

Smith, P., 2001. How do foreign patent rights affect US exports, affiliate sales, and licenses? Journal of International Economics 55 (2), 411–439.

UNCTAD, 2010. Foreign direct investment, the transfer and diffusion of technology, and sustainable development. United Nations Conference on Trade and Development.

Viallefont, V., Raftery, A., Richardson, S., 2001. Variable selection and Bayesian Model Averaging in case-control studies. Statistics in Medicine 20 (21), 3215–3230.

Wei, S., 2000. How taxing is corruption on international investors? Review of Economics and Statistics 82 (1), 1–11.

Wooldridge, J., 2002. Econometric analysis of cross section and panel data. The MIT Press.

World Bank, 2010. Investing Across Borders 2010. Oxford University Press.

Curriculum Vitae

10/2008–05/2012	PhD Program in Economics, Ludwig-Maximilians-Universität München
10/2010–09/2011	Visiting Scholar, University of Washington, Seattle, USA
10/2007–08/2008	MPhil in Economics, Queens' College, University of Cambridge, UK
10/2006–07/2007	Postgraduate Diploma in Economics, University of Warwick, UK
09/2002–09/2006	Diplom-Informatiker (FH), Fachhochschule für Oekonomie & Management Essen
09/2002–03/2006	Diplom-Kaufmann (FH), Fachhochschule für Oekonomie & Management Essen
06/2002	Abitur, Heinrich-Heine-Gymnasium Bottrop
02/1983	geboren in Dinslaken