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Trade, Foreign Direct Investment, and International Technology Transfer

A Survey

Kamal Saggi

How much a developing country can take advantage of technology transfer from foreign direct investment depends partly on how well educated and well trained its workforce is, how much it is willing to invest in research and development, and how much protection it offers for intellectual property rights

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Summary findings

Saggi surveys the literature on trade and foreign direct investment — especially wholly owned subsidiaries of multinational firms and international joint ventures — as channels for technology transfer. He also discusses licensing and other arm's-length channels of technology transfer. He concludes:

- How trade encourages growth depends on whether knowledge spillover is national or international. Spillover is more likely to be national for developing countries than for industrial countries.
- Local policy often makes pure foreign direct investment infeasible, so foreign firms choose licensing or joint ventures. The jury is still out on whether licensing or joint ventures lead to more learning by local firms.
- Policies designed to attract foreign direct investment are proliferating. Several plant-level studies have failed to find positive spillover from foreign direct investment to firms competing directly with subsidiaries of multinationals. (However, these studies treat foreign direct investment as exogenous and assume spillover to be horizontal — when it may be vertical.) All such studies do find the subsidiaries of multinationals to be more productive than domestic firms, so foreign direct investment does result in host countries using resources more effectively.
- Absorptive capacity in the host country is essential for getting significant benefits from foreign direct investment. Without adequate human capital or investments in research and development, spillover fails to materialize.
- A country's policy on protection of intellectual property rights affects the type of industry it attracts. Firms for which such rights are crucial (such as pharmaceutical firms) are unlikely to invest directly in countries where such protections are weak, or will not invest in manufacturing and research and development activities. Policy on intellectual property rights also influences whether technology transfer comes through licensing, joint ventures, or the establishment of wholly owned subsidiaries.

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Trade, Foreign Direct Investment, and International Technology Transfer: A Survey*

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1. Introduction

It is well understood that economic growth results either from accumulation of factors of production or from improvements in technology or both. To encourage the generation of new knowledge, industrialized countries have elaborate systems of intellectual property rights (IPRs) in place and conduct majority of the world's research and development (R&D). Technologies resulting from such R&D spread throughout the world through a multitude of channels. At a fundamental level, one can draw a distinction between international trade in technology and other indirect channels of international technology transfer such as trade in goods and international movement of factors of production. This paper critically surveys the literature that explores the role of trade and foreign direct investment (FDI) as channels of international technology transfer.[1] With respect to FDI, a distinction is made between wholly owned subsidiaries of multinational firms and international joint ventures. Furthermore, FDI is contrasted with arms length channels of technology transfer such as licensing.

The paper argues that while the literature has done a decent job of outlining the various potential channels through which international technology transfer occurs, not enough is known, both in theory and practice, about the *relative importance* of each of these channels.[2] This lack of knowledge automatically limits our understanding of the role policy plays in facilitating the process of international technology transfer. For example, the literature still continues to debate whether increased openness to trade encourages economic growth. Nevertheless, as a practical matter, few economists advocate the imposition of trade restrictions.[3] In fact, the general feeling seems to be that traditional analyses may very well understate the true cost of protectionism since most such analyses utilize static models and ignore the dynamic costs of trade protection. Underlying this view is the notion, that, somehow, trade of goods and services, foreign direct investment (FDI) and interaction among countries in various other forms all play a crucial role in improving not only the global allocation of physical resources but also in transmitting technology globally. However, how

[1] To restrict the focus of the paper, the international movement of labor (for example, the process of reverse brain drain and movement of consultants) is not discussed.

[2] Purely for the sake of clarity, the paper refers to the spread of know-how across countries as international technology transfer and within a country as technology diffusion.

[3] See Dollar (1992), Sachs and Werner (1995), for empirical studies that support the view that open economies grow faster and Rodriguez and Rodrik (1999) for a recent, more critical view of this literature and its main conclusion.

exactly this transmission occurs is not yet fully understood, making international technology transfer an active area of research.

Section 2 of the paper discusses dynamic trade models that shed light on the complex relationship between technology and trade. These models frequently lead to ambiguous welfare conclusions. Much as one may desire, the existing literature (both theoretical and empirical) simply does not provide a blanket endorsement of trade as an engine for growth.[4] However, it is also not the case that 'anything can happen'. In fact, the theoretical literature suggests that the scope of knowledge spillovers is a crucial determinant of whether or not trade necessarily encourages growth (Grossman and Helpman, 1995). However, empirical evidence has failed to settle the issue: some studies discover that knowledge spillovers have a limited geographical scope, whereas others find the opposite.

Yet, even a definitive measurement of the scope of knowledge spillovers would not settle the issue, particularly for those interested in the process of international technology transfer. What determines the scope of knowledge spillovers? This paper argues that a central role must belong to interaction between innovators (potential suppliers of technology) and those firms and entrepreneurs that seek to gain access to newer technologies either through costly imitation or through technology licensing and other forms of collaboration with innovators. This perspective implies that a fair bit of technology transfer may indeed be endogenous.

In his excellent discussion of the special properties of knowledge as an economic good, Romer (1990) makes the important point that knowledge is a non-rival good: it can be used simultaneously by two different agents. One must be careful however, to not jump from this argument to the claim that knowledge can be *transferred* across agents at zero cost. If this were true, the room for policy intervention with respect to international assimilation of technology would be severely limited since any technology transfer that would yield even a minutely positive return to any agent would take place automatically.[5] The non-rival nature of knowledge only implies that *if two agents are willing to pay the cost* of adopting a new idea or a technology, they can do so

[4] This is not surprising. Introducing dynamics in an interesting fashion often requires multiple departures from the neoclassical model of perfect markets. Imperfect competition and externalities are central to the new dynamic models of trade and such distortions can easily lead to perverse results. Of course, the argument cuts both ways. Introducing such elements in the traditional static model also furnishes additional arguments in support of free trade. Nevertheless, the point is that the unconditional case for free trade can longer be made purely on the basis of logic (see Krugman, 1987, for a pragmatic argument for free trade even in a world full of market failures).

[5] See Pack (1992) for an overview of what can be reasonably expected in terms of technology transfer to developing countries, given that the *potential* for transfers is large.

without interfering with each other's decisions. Much empirical evidence (Teece 1976, Mansfield and Romeo, 1980, Ramachandran, 1993) indicates that it is indeed costly to transfer technology internationally. In his survey of twenty nine technology transfer projects, Teece (1976) found that on average such costs were approximately twenty percent of the total costs of the project and in some cases, they were as high as sixty percent.

The fact that international technology transfer occurs through a multitude of channels makes it especially difficult to arrive at an *aggregate* measure of the activity and hence to assess its contribution to economic growth in both source and host countries.[6] In fact, if one could somehow rank the different channels of technology transfer in terms of their relative importance, empirical analysis could then proceed by ignoring the relatively unimportant of these channels. However, given that multiple options exist in theory, the dominance of any one channel in the data *would itself require explanation*. And indeed, the emergence and expansion of multinationals, given the existence of alternative arrangements for transacting in technology, has been viewed as a phenomenon that requires explanation. This question is addressed in greater detail in section 4.

A major question of interest is that once a technology has been introduced into a country, does it subsequently diffuse throughout the rest of the economy? The presence of barriers across countries, as well as international differences in market conditions and policy environments necessarily imply that the technology diffusion within a country may be considerably easier than international transfer of technology. For example, mobility of labor is severely constrained only at the international level (exceptions are contact with consultants, return of foreign educated natives etc.). Thus, labor turnover across firms may be crucial for driving technology diffusion within a country and not play as big a role in international technology transfer. Sections 3 and 4 discuss the role of technology licensing, imitation, and FDI in the process of international technology transfer. Several key questions are addressed: through what channels does imported technology diffuse within the host country? Do local firms enjoy technology spillovers from FDI? If so, how are these realized?

One goal of this paper is to help identify the role policy plays in facilitating international technology transfer. The range of relevant policies is clearly quite large. To limit the scope of the paper, I only address the role of trade, FDI, and IPR policies (section 5). Given the central

[6] As can be expected due to the difficult nature of the problem, not much research has taken this question head on. Instead, most research, both theoretical as well as empirical, has tended to focus on one or two channels of technology transfer. Of these, trade and FDI have received most of the attention.

questions of interest, the literature on FDI and IPR policy is discussed in greater detail than that on trade policy. Section 6 presents the main conclusions of the paper.

2. Knowledge spillovers through trade

Much of the relevant literature has emphasized two aspects of the relationship between trade and technology. The first of these arises because trade alters the allocation of resources in an economy while the second is related to the role trade plays in transmitting knowledge internationally. In fact, as the literature notes, the implications of these two roles of trade are in fact quite intertwined.

Since much of the literature emphasizing trade's role in transmitting knowledge derives from closed economy models of endogenous growth, a brief digression will help put things in context. Traditional growth theory sought the explanation of economic growth in terms of accumulation of resources. Capital accumulation was seen as the major determinant of economic growth and a natural conclusion of this research was that, unless the return to capital accumulation could stay bounded away from zero, growth would peter out in the long run. A natural implication of this finding was that, over time, one should expect poor countries to eventually converge to the per capita income levels of the rich countries.[7]

Standard neoclassical growth models assume costless technology transfer by positing a common production function across countries. Note that the fact that chosen production techniques differ across countries is not evidence against the neoclassical assumption: when faced with different factor prices (due to differences in factor endowments), agents will typically adopt different techniques in different countries. Thus the real question is whether agents in different countries can *access* the global pool of technologies at *the same cost*. Parente and Prescott (1994) have emphasized barriers to technology adoption as a key determinant of differences in per capita income across countries. In their model, while any firm can access the underlying stock of knowledge in the world economy, the cost of such access may differ across countries due to differences in legal, regulatory, political, and social factors. Thus the argument is that some countries make it inherently costlier for their firms to adopt modern technologies and thereby retard the development of the entire economy. In fact, Parente and Prescott go on to suggest that trade may affect growth by lowering the barriers to technology adoption.

In contrast to neoclassical models that stress capital accumulation, the new growth theory emphasizes endogenous technological change and the accumulation of human capital (Lucas, 1988).[8] Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1990), and Anant, Segerstrom, and Dinopoulos (1991) were among the pioneers of R&D based models of economic growth. These models were able to provide a coherent framework for the Schumpeterian notion of 'creative destruction'. While they differ from each other in important ways, one underlying idea common to these models is that entrepreneurs conduct R&D to gain temporary monopoly power where such a privilege is made possible due to the provision of intellectual property rights.

Grossman and Helpman (1991) provide a unifying framework for two widely used strands of R&D based endogenous growth models: the 'varieties only' model that builds on foundations laid by Dixit and Stiglitz (1977), Ethier (1982), and Romer (1990), and the `quality ladders' model developed by Aghion and Howitt (1990), Segerstrom et. al. (1991) and Grossman and Helpman (1991). In a closed economy, growth is sustained in the `variety model' through the assumption that the creation of new products expands the knowledge stock, which then lowers the cost of innovation. Thus, as more products are invented, while the profits of subsequent innovators are lower because of increased competition (no products disappear from the market in this model), so are the costs of inventing new products. In the quality ladders model, since consumers are willing to pay a premium for higher quality products, firms always have an incentive to improve the quality of products. The important assumption that sustains growth in this model is that every successful innovation allows *all* firms to study the attributes of the product and then improve upon it. Patent rights restrict a firm from producing a product invented by some other firm but *not* from using the knowledge (created due to R&D) that is embodied in that product. Thus, as soon as a product is created, knowledge needed for its production becomes available to all and such knowledge spillovers ensure that anyone can try to invent a higher quality version of the same product.

While R&D based endogenous growth theory is quite appealing theoretically, empirical evidence does not provide a strong endorsement (Pack, 1992). In fact, Jones (1995a, and 1995b) has explicitly tested the empirical implications of R&D based models of economic growth and found that the data reject these implications. One should be careful, however. Rejecting a

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[7] The evidence on convergence is weak; while some countries such as South Korea, Taiwan, and Hong Kong did achieve enviable rates of growth, most developing countries do not seem to be on any path of convergence toward rich countries (Pritchett, 1997).

particular model of R&D based economic growth does not imply that R&D is not an important determinant of growth. In fact, a reasonable conclusion may be that while R&D is crucial for the generation of new ideas and hence economic growth, early variants of the R&D based growth models do not adequately capture the relationship between R&D and growth. In fact, the newer strand of growth theory has not abandoned R&D as a determinant of growth; instead, it has focused on creating models that do not have the 'scale effects' that Jones demonstrated as not supported by the data.[9]

If, as R&D based models of growth argue, new products result from new ideas, trade in goods can help transmit knowledge internationally. This is the central insight of many open economy growth models that explore the relationship between trade and growth. There are two strands of multi-country models of endogenous growth: those that study trade between identical countries and those that have a North-South structure. While knowledge spillovers are central to both, technology transfer in the sense emphasized in this paper is a central feature only of North-South models. Some of the prominent early works are Krugman (1979), Rivera-Batiz and Romer (1991), and Grossman and Helpman (1991). The literature is now rather large and a full discussion requires a survey of its own (see Grossman and Helpman, 1995). Yet, North-South models that emphasize the product cycle nature of trade have been particularly useful for understanding international technology transfer and merit some further discussion.

The basic idea of product cycle models (for details see Grossman and Helpman, 1991) is that new products are invented in the North and due to lower relative Southern wage (endogenous in the model) firms in the South can successfully undercut Northern producers once they succeed in imitating Northern products. A typical good is initially produced in the North till either further innovation (in the quality ladders model) or successful Southern imitation (in both the variety model and the quality ladders model) makes profitable production in the North infeasible. Consequently, either production ceases all together (if product is innovated over) or shifts to the South (if imitated). Thus, prior to imitation, all products are exported by the North whereas post imitation they are imported, thereby completing the cycle. These models capture technology driven trade and have been generalized to consider technology transfer more explicitly. Its clear from the

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[8] For our purposes, the literature on R&D based growth models is clearly more relevant and we restrict attention to this strand of growth theory.

[9] Roughly speaking, scale effects imply that large economies grow faster than small economies. See Dinopoulos and Thompson (1999) for a lucid discussion of scale effects in endogenous growth models.

preceding discussion, for example, that FDI or licensing (choices available to innovators for producing in the South) were not considered in the early variants of these models.

What do R&D based models of growth imply about the effect of trade on growth? The central conclusion of this line of research literature is that much of importance hinges on whether knowledge spillovers are national or international in nature (Grossman and Helpman, 1995). It turns out that most perverse possibilities usually arise for the case of national knowledge spillovers.[10] If not, by and large, the literature endorses the common assertion that trade is an engine of growth.[11] Note that this perspective is more relevant for North-North models of trade since international knowledge spillovers (of one form or another) are *assumed* in North-South models of trade, where the South is modeled as a pure imitator.[12]

Two questions are of immediate interest. First, what does empirical evidence say about the scope of knowledge spillovers? Second, should research focus primarily on determining the geographical scope of spillovers? As can be expected, there exists no simple answer to the first question. The frequently witnessed agglomeration of R&D intensive industries (such as in Silicon Valley) suggests that spillovers may be primarily local. On the other hand, several studies find that R&D activity in a country is *not* strongly correlated with its own productivity growth, suggesting that results of R&D in one country may spill over substantially to other countries. Eaton and Kortum (1996) find that more than 50% of the growth in some OECD countries derives from innovation in the United States, Germany, and Japan. Yet they also report that distance inhibits the flow of ideas between countries whereas trade enhances it. In their micro-level study of the semi-conductor industry, Irwin and Klenow (1994) find that learning (resulting from production) spills over as much across national borders as it does between firms in the same country. Similarly, Coe and Helpman (1995) and Coe et. al. (1997) argue that international R&D spillovers are substantial

[10] It is easy to see that if such dynamic externalities are national in scope, trade can induce perverse outcomes by altering the allocation of resources in a country.

[11] The debate among economists about what factors can help account for the explosive growth of countries like Hong Kong, South Korea, and Taiwan also deserves mention here. While some argue that economic growth in these countries was a driven largely by accumulation of resources (Young 1995), others argue that it is improvement in productivity (driven partly through trade) that played a large role (see Nelson and Pack, forthcoming, for a clear lucid discussion). Nevertheless, even if capital accumulation was the driving force, it is not clear why capital accumulation took place at such a high rate: what kept the returns to capital accumulation so high? One possibility is that technology transfer (again partly through trade) kept the marginal product of capital from falling and kept investment rates high (Nelson and Pack, forthcoming).

[12] In North-South models, the more interesting question is how Southern imitation affects incentives for innovation in the North.

and that trade is an important channel of such spillovers.[13] However, Keller (1998) casts doubt on the latter assertion by generating results similar to those of Coe and Helpman (1995) for randomly generated trade weights.[14] So what is one to make of all this conflicting evidence? As Grossman and Helpman (1995) note, the truth is quite likely that knowledge spillovers are neither exclusively national nor international; they are probably both to some extent.[15] Second, as noted earlier, one needs to dig deeper into the issue: focusing primarily on the geographical scope of spillovers may result in glossing over what really is the heart of the matter after all.

In most theoretical models, knowledge spillovers across countries are either *assumed* to be national or international in scope and then the predictions of the two scenarios are contrasted. Following this line of argument, the goal of the empirical economist simply becomes one of determining which assumption is indeed appropriate. Yet, such an approach sits rather uncomfortably with the central tenets of the literature on trade and growth. A major theme of this literature is that technological change occurs due to intentional and costly investments undertaken by firms and entrepreneurs seeking to profit from monopoly power resulting from successful innovation. If so, *arbitrage in knowledge*, which is basically what the spread of know-how across countries amounts to, cannot be totally exogenous to economic activity either. The same set of agents that invest heavily in creating new technologies face strong incentives to control the spread of their hard earned successes. If such control were not possible, they would have little incentive to make those investments in the first place. Thus, if inventors do play a role in controlling the rate at which their technologies spread internationally, and for the theory of trade and innovation to be

[13] Using data for 87 countries, Hakura and Jaumotte (1999) find that trade indeed serves as a channel of international technology transfer to developing countries and that inter-industry trade plays a stronger role in technology transfer than intra-industry trade. Since intra-industry trade is more pervasive among developed countries than it is between developed and developing countries, an immediate implication of their findings is that developing countries will enjoy relatively less technology transfer from trade than developed countries.

[14] In a response to Keller (1998), Coe and Hoffmaister (1999) raise some doubts about Keller's findings. They argue that Keller's 'random' weights are not actually random and when alternative weights are used, estimated international R&D spillovers are non-existent for the case of random weights, as suggested by theory. Using estimates of international R&D spillovers from Coe and Helpman (1995) and Coe et. al. (1997), Bayoumi, et. al. (1999) simulate the impact of changes in R&D and in exposure to trade on productivity, capital, output and consumption in a multi-country model (IMF's MULTIMOD econometric model). Their simulations indicate that R&D can affect output not only directly but also indirectly by stimulating capital investment. Incidentally, this finding is also of interest for the debate regarding the Asian growth miracle.

[15] Evidence on this issue continues to come in. In a recent paper, using firm level data from the U.S. and Japan, Branstetter (1996) comes out strongly in favor of the limited (national) scope of knowledge spillovers.

internally consistent this is almost a requirement, then it is misleading to focus primarily on the geographical scope of spillovers without giving innovators some role in that process.

Of course, the incentives of innovators are not the only determinant of the scope of knowledge spillovers. One most also consider the incentives facing potential buyers and imitators of technologies. As we will see, by and large, the existing literature in this area has not paid adequate attention to the rich choice set faced by both potential suppliers and buyers of technology. We next discuss the literature that seeks to explain the emergence of multinational firms, since such firms play a central role in international technology transfer.

3. Explaining FDI: Location and Mode of Production

There are two distinct questions that a firm seeking to serve foreign markets must contend with. First is the issue of location of production: is it better to produce the good in the home country and export to foreign markets(s) or is production abroad more profitable? Second, if production is to be located abroad, how should technology be transferred overseas? Firms can choose from a variety of arrangements that differ in their relative use of markets and organizations. At the one extreme lie technology transfers to wholly owned subsidiaries while at the other lie transfers to unrelated parties via technology licensing. We address each of these questions in turn.

3.1. Exports versus Production Abroad

As noted above, when serving a foreign market, a firm can choose from a menu of options. In this context, the choice between exports and FDI has received the most attention in the economics literature. Note, first that, this question assumes that exports and direct investment are substitutes for one another. Is this widely used assumption justified? A first reading of the empirical literature on the question suggests not. Most existing empirical work usually uncovers a *complementary* relationship between exports and foreign affiliate sales. Lipsey and Weiss (1981) is a prominent example of such research. They find that affiliate sales are positively correlated with exports at the industry level. Firm level studies such as Lipsey and Weiss (1984), Graham and Mutti (1991), and Blomström et. al. (1993) also uncover a complementary relationship between trade and FDI.

Does the evidence imply that most theoretical models are flawed?[16] Perhaps not. A reasonable interpretation of the existing evidence, as suggested by Blonigen (1999), is simply that

[16] Of course, it is easy to construct theoretical models in which exports and sales of affiliates are complementary. Introducing a vertical structure in production obviously accomplishes the task; thus most

such studies are finding *net* complemenatrity: aggregation bias in the data simply buries the substitution effects emphasized in theoretical models. The major contribution of Blonigen (1999) lies in using *product level* data since it as at this level that the substitution effect is really implied by theory. He uses data on Japanese production and exports to the US for two types of products: automobile parts and automobiles.[17] Only a study of this type can really be expected to sort out the complementary nature of trade between intermediate goods and affiliate sales on the one hand and the substitutability of exports of final goods and FDI on the other. Not surprisingly, Blonigen's (1999) results conform nicely to the theory: exports of intermediate goods and sales of affiliates are complements whereas exports and sales of final goods are substitutes. The only unresolved issue is why aggregate studies continue to find a net complementary relationship.[18] The explanation here probably comes from a fact noted much earlier in the literature by trade theorists and especially emphasized by Ethier (1982): most trade between industrialized countries involves exchange of intermediate goods.[19] Thus, if such trade is indeed pervasive, one should expect a strong complementary relationship between exports and FDI at the aggregate level.

Existing theoretical models have also explored strategic considerations that influence the choice between exports and FDI (see Horstmann and Markusen, 1992, Norman and Motta, 1993, and Motta and Norman, 1996). As is clear, the presence of trade barriers creates a tariff-jumping motive for FDI.[20] However, the preceding research highlights the interdependence of decision making between multinational firms. For example, when two firms are exporting to a foreign market, a switch from exports to FDI by one creates an incentive for FDI on the other firm's part, who finds itself at a competitive disadvantage (Lin and Saggi, 1999, call this the competitive incentive for FDI).[21]

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types of outsourcing which involves basic stages of production being carried out in one location and other stages such as R&D and/or marketing being done elsewhere would imply a complementary relationship between exports and FDI.

[17] Such a study is particularly useful in the context of Japanese firms who import relatively large amounts of parts from Japan and seem quite unwilling to substitute between US and Japanese parts.

[18] Another issue that complicates the story is endogenity of demand. Some authors have argued that the location of production may itself alter the demand function facing the foreign firm's product because consumers may expect better after sales service or commitment to the local market if the foreign firm produced the good locally.

[19] The literature on intraindustry trade as derived from Dixit-Stiglitz's (1977) model may over-emphasize the role of product differentiation and consumer emphasis on variety. As Ethier (1982) noted, actual trade is in intermediate goods needed for production.

[20] Bhagwati et. al. (1987 and1992) have even argued that the mere threat of future trade restrictions may lead to anticipatory investment (termed 'quid pro quo' investment) by foreign firms.

[21] An old tradition in the management literature describes the interdependence between the decision making of large multinationals as 'follow the leader' behavior.

As far as the static choice between exports and production abroad is concerned, existing theoretical models seem reasonably well developed. However, this is a limited perspective: firms face a dynamic problem and not a one-time choice between exports and FDI. They may, *and indeed do*, switch between the two activities over time. Unfortunately, the literature exploring the dynamics of optimal entry strategies into foreign markets is scarce. A recent study by Roberts and Tybout (1997), while not exploring the choice between different entry strategies does highlight the role of sunk costs in determining the dynamic behavior of exporters. Using data for Colombian manufacturing plants, Roberts and Tybout (1997) show that prior exporting experience is an important determinant of current tendency to export as well as profitability of exporting. Their findings show that sunk costs are indeed relevant for exporting behavior and that learning is subject to strong depreciation: the entry costs of a plant that has never exported do not differ significantly from plants that have not exported for more than two years.

While Roberts and Tybout (1997) do not consider other modes of serving foreign markets, their insight can be utilized in a more general context. Suppose firms also have the option of FDI. Building on their approach, one can view the choice between exports and FDI as a choice between two different technologies, where exports entail a higher marginal cost and a lower fixed (sunk) cost than FDI. Under uncertainty, if firms do face such a cost structure, an interesting dynamic relationship between exports and FDI may emerge. Saggi (1997) builds a two-period model to examine a firm's choice between exports and FDI in the face of demand uncertainty. First period exports yield information about demand in the foreign market. As a result, first period exports have an option value: if a significant portion of the fixed cost of FDI is sunk, it is optimal for a firm to export in the first period and do FDI iff demand abroad is large enough. Clearly, the preceding argument is not specific to demand uncertainty and can be generalized with respect to other types of uncertainty about which sales via exports can yield information.[22] Of course, generalizing the preceding argument to the case of multiple firms also creates the possibility of informational externalities amongst investors: experience of one firm may impart lessons to others. Such externalities may be particularly relevant for FDI into many developing and formerly communist countries (China and much of Eastern Europe) that have recently altered their policies in a

[22] Similarly, exports and initial FDI may be strongly complementary for another reason: firms are not likely to shift the entire production process to a new location immediately. If initial investment is found to be profitable, local sourcing may reduce the need for importing intermediates. Over time, such substitution effects may become stronger and the complementarity between exports and FDI may become weaker (assuming local suppliers are indeed competitive or local production is consistent with comparative advantage considerations).

remarkable manner. As a result, firms from industrialized countries have gained access to hitherto closed markets and to many cheap locations of production for the first time. But at the same time, they have little prior experience in operating in these new environments. This lack of experience coupled with the complexity surrounding the FDI decision implies that firms seeking to invest in these markets can learn valuable lessons from the successes and failures of others.[23] In their survey of Japanese firms planning investments in Asia, Kinoshita and Mody (1997) found that information, both private and public, plays an important role in determining investment decisions. They argue that information regarding many operational conditions (such as functioning of labor markets, literacy and productivity of the labor force, timely availability as well as quality of inputs etc.) may not be available publicly. In such a scenario, information is either gathered through one's own direct experience or through the experience of others. Thus, present investment is a function of one's own investment as well as those of rival investors. Their empirical analysis finds that a firm's current investment is strongly affected by its own past behavior as well as investments by its rivals.

While the degree of fixed/sunk costs may play a role in determining the choice between licensing, joint ventures, and FDI, other considerations are probably more important. A new foreign plant is the primary contributing factor behind higher fixed/sunk costs of FDI relative to exports, and this factor is unlikely to be of first order importance in determining the choice between different entry modes that are distinguished primarily by the extent of ownership.

3.2. Mode of Operation: Licensing, Joint Venture or FDI?

A major question in the theory of the multinational firm is when and why firms choose to internalize technology transfer thereby foregoing the option of utilizing market based alternatives such as technology licensing. The relevant economics literature regarding internalization has been discussed extensively in Markusen (1995) and Caves (1996).[24] Here, we restrict attention to the central conclusions of this line of research, particularly those that relate to technology transfer.

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[23] FDI involves hiring foreign labor, setting up a new plant, meeting foreign regulations, developing new marketing plans, decisions that can me made properly only with adequate information. In this context, decisions made by rival firms can lower a firm's fixed cost by helping avoid mistakes. See Lin and Saggi (1999) for a duopoly model in which the firm first to switch to FDI from exporting confers a positive externality on the subsequent investor by lowering its fixed cost of FDI.

[24] There exists a vast literature in the field of international business that deals with some of the very questions posed above. By and large, this literature involves empirical tests of the OLI (ownership, location, and internalization) paradigm formulated by John Dunning. To limit scope, this literature is discussed only to the extent that it offers new insights with respect to the *economics* of multinational firms. See Caves (1996) for a relatively recent survey of this literature.

Recently, Markusen and Maskus (1999) have suggested that the literature that attempts to link the emergence of multinational firms with firm and country level characteristics can be understood to emerge from a common underlying model – the 'knowledge-capital' model.[25] As Markusen (1998) argues, this model rests on the fact that knowledge capital has a public good property: it can be utilized in multiple locations simultaneously. Thus, any innovation can then be fruitfully applied at multiple plants dispersed all over the world, giving rise to horizontal multinational firms. Markusen and Maskus (1999) show that there is indeed strong empirical support for this horizontal model of multinationals.

How does the knowledge-capital model explain internalization? Once again the public good nature of knowledge occupies a central role. If licensees (or local partners under a joint venture) can get access to the multinational's proprietary knowledge, the value of such knowledge can be dissipated either because of increased competition (Ethier and Markusen, 1991, Markusen, 1999, and Saggi, 1996 and 1999) or because the local partner has inadequate incentives to protect the multinational's reputation (Horstmann and Markusen, 1987). The incentive to prevent the dissipation of knowledge based assets is reflected in the fact that multinationals transfer technologies of new vintage via direct investment, preferring to license or transfer their older technologies via joint ventures (see Mansfield and Romeo, 1980).[26]

In recent empirical paper, Smarzynska (1999a) focuses on intra-industry differences in R&D intensity as a determinant of mode of entry chosen by firms investing in eastern European countries. Like past work, this study finds that a firm's R&D expenditure is negatively related to the probability of a joint venture and positively related to greenfield entry. Furthermore, a firm's R&D expenditure *relative* to the rest of the industry is positively correlated with the probability of greenfield entry in high technology sectors. More interestingly, however, in low technology sectors, higher relative R&D expenditure by a firm actually increases the likelihood of a joint venture rather than a greenfield entry. Thus, a firm's R&D expenditure relative to others in an industry and the aggregate R&D expenditure of the industry relative to other industries may both interact in subtle ways to influence the choice between alternative entry modes. Smarzysnka (1999a) argues that protecting one's technology is of greater concern in high technology industries, thereby encouraging technological leaders to adopt direct entry. However, it is also possible that in

[25] Papers that deal directly with technology transfer are: Horstmann and Markusen (1987 and 1996), and Ethier and Markusen (1991). See also Markusen (1998) for a good overview.

[26] Of course, it may be easier to trade via the market when technology is older since asymmetric information problems are likely to be less severe.

industries characterized by a fast pace of technological change, any technology leakage will hurt a firm for only a short period of time.[27] Furthermore, the formation of joint ventures will be easier in relatively mature host industries since suitable local partners can be found more easily. Thus, her results call for a careful interpretation but raise some interesting possibilities and further questions.

Foreign firms may not be the only one's that have valuable information that may be subject to dissipation due to diffusion to other firms. Horstmann and Markusen (1996) argue that a potential licensee in the host country may have better information about local demand and can use this information to extract rents from the licenser. Such agency costs can also be utilized to explain the dynamics of optimal entry modes. In his studies of British multinationals, Nicholas (1982 and 1983) found that eighty eight percent initially sold their products via a contract with a local agent before converting to directly owned sales or production branches. Furthermore, the decision to terminate the licensing arrangement was based on a desire to avoid agency costs, and once the multinational had acquired the information it needed via its alliance with the local partner, continuing the agency relationship was no longer attractive. Similarly, in their survey of Japanese multinationals in Australia, Nicholas et. al. (1994) found that sixty percent used a local agent before making a direct investment and sixty nine percent exported to Australia before making a direct investment of any sort. One can view such temporary licensing as a method of information acquisition on the part of the foreign firm, as opposed to the local firm seeking superior production technology.

In Horstmann and Markusen's (1996) model, when the multinational firm's fixed cost of investment are high relative to the agent's and there is risk of large losses due to low demand, the multinational opts for an initial licensing contract that becomes permanent ex post in case of low demand. Their analysis can be applied to examine the choice between a joint venture and a wholly owned subsidiary, except that cost uncertainty may be more relevant for this scenario than demand uncertainty. For example, if the productivity of foreign labor is in doubt, forming a joint venture may present a low (fixed) cost option. If labor productivity turns out to be high, an acquisition of the foreign partner may be optimal ex post, resulting in the establishment of a wholly owned subsidiary.

[27] Theory does not provide a clear support for her terminology (those doing more R&D are deemed technological leaders). Firms that have been driven out of the market may have a stronger incentive to invest in R&D than present technological leaders. In the real world, a measure of cumulative R&D over a time period may serve as a better index of technological superiority.

By and large, however, dynamic issues remain under explored in the literature. While the comparative statics of existing models help gain some partial intuition about forces that are important for dynamic choice, such an approach is a poor substitute for explicit dynamic modeling. Several central questions remain under explored: What determines the sequencing pattern of different activities? For example, do firms first form joint ventures and then proceed with foreign direct investment? If so, why is this so? To what extent do the dynamic choices of foreign firms result from their efforts to restrict diffusion of their own technology while at the same time maximizing the acquisition of valuable information possessed by local firms? Do host country welfare and the rate of technology diffusion depend upon the sequencing pattern? We take up the last question in section 6.

4. Foreign direct investment: technology transfer and spillovers

While convincing evidence of the dominance of FDI as a channel of international technology transfer (among those channels that directly involve the owner of the technology being transferred) is hard to find, several facts hint in that direction. For example, in 1995, over eighty percent of global royalty payments for international transfer of technology were made from subsidiaries to their parent firms (UNCTAD, 1997). However, these payments only record the *explicit sale* of technology and give us no clue about the importance of technology transfer via FDI relative to technology transfer via imitation, trade in goods etc. Nevertheless, what makes FDI especially important is that unlike trade in goods, where developing countries try to glean whatever information they can from the products and services imported or import capital goods that embody modern technology, FDI involves explicit trade in technology. One may expect FDI to have a first order effect on technology transfer, just as other arms length transactions such as licensing and other turnkey projects.

Yet another confirmation of the strong role FDI plays in transmitting technology internationally comes from the inter-industry distribution of FDI. It is well known that multinational firms are concentrated in industries that exhibit a high ratio of R&D relative to sales and a large share of technical and professional workers (Markusen, 1995). In fact, it is commonly argued that, multinationals rely heavily on intangible assets such as superior technology to successfully compete with local firms who are better acquainted with the host country environment.

By encouraging FDI, developing countries hope not only to import more efficient foreign technologies but also to generate technological spillovers for local firms. Not surprisingly, there

exists a large literature that tries to determine whether or not host countries enjoy spillovers from FDI. One needs to be clear about the meaning of word `spillover': a distinction can be made between pecuniary externalities (that result from the effects of FDI on market structure) and other pure externalities (such as the facilitation of technology adoption) that may accompany FDI. A strict definition of spillovers would only count the latter and this is the definition employed in this paper.[28]

The central difficulty is that spillovers, as defined above, will not leave a paper trail -- they are externalities that the market fails to take into account. Nevertheless, several studies have attempted the difficult task of quantifying spillovers and we discuss them below. But a prior question is what are the potential channels through which such spillovers may arise?[29] At a general level, the literature suggests the following potential channels of spillovers:

Demonstration effects: local firms may adopt technologies introduced by multinational firms through imitation or reverse engineering.

Labor turnover: workers trained or previously employed by the multinational may transfer important information to local firms by switching employers or may contribute to technology diffusion by starting their own firms.

Vertical linkages: multinationals may transfer technology to firms that are potential suppliers of intermediate goods or buyers of their own products.

Let us examine each of these channels in some detail, discussing empirical evidence wherever it exists.

4.1. Facilitation of technology adoption

In its simplest form, the demonstration effect argument states that exposure to the superior technology of multinational firms may lead local firms to update their own production methods. The main point here is that in the absence of FDI, it may simply be too costly for local firms to acquire the necessary information for adopting new technologies if they are not first introduced in

[28] In other words, if FDI spurs innovation in the domestic industry by increasing competition, we do not view that as a `spillover' from FDI but rather a benefit enjoyed by the host country that works its way through the price mechanism and the market equilibrium. Of course, it is very difficult to empirically isolate the pure externalities from FDI from its other effects that work through the market. Furthermore, policy ought to be based on the aggregate effect of FDI on welfare, not just on the extent of positive externalities from FDI.

[29] In fact, a more difficult question can be asked: is it reasonable to even *expect* spillovers to occur from FDI? It seems natural to assume that multinationals have much to gain from preventing the spread of their technologies to potential rivals. A possible exception to this argument arises when technologies may diffuse to potential suppliers of inputs or buyers of goods and services sold by multinationals.

the local economy by multinationals (and hence demonstrated to succeed in the local environment). Incidentally, the demonstration effect argument relates well to the point made by Parente and Prescott (1994) that trade may lower costs of technology adoption. Clearly, *geographical proximity* is a vital part of the demonstration effect argument. As noted earlier, empirical evidence on the geographical scope of R&D spillovers is mixed. However, studies that reach optimistic conclusions with respect to the international nature of R&D spillovers typically involve data from industrialized countries and therefore require qualification. Geographical proximity may indeed be crucial for developing countries that are not as well integrated into the world economy and may have few alternative channels of absorbing technologies, at least over a reasonable time horizon.

The main insight of the demonstration effect argument is that FDI may expand the set of technologies available to local firms. If so, this is a potential positive externality. One must be careful, however since a mere expansion in choices need not imply faster technology adoption, especially if incentives for adoption are also altered due to the impact of FDI on domestic market structure. FDI may expand choices but it generally also increases competition.[30] The net effect on the incentives for adopting new technologies may indeed be ambiguous.

Suppose FDI does lower the cost of technology adoption and leads to faster adoption of new technologies by local firms. Does that imply that, *relative to trade* (i.e. a scenario where foreign firm(s) export to the domestic or world market), inward FDI necessarily generates spillovers for the local economy? A point to keep in mind is that foreign firms will face more severe competition as a result of faster technology diffusion. Foreseeing the consequences of faster diffusion, foreign firms may alter the very terms of their original technology transfer. For example, a foreign firm may choose to transfer technologies of lower quality when there is a risk of leakage or adoption of the technology by local firms. It is conceivable, however, that due to their larger size and other advantages they enjoy in the product market, multinationals can alter the market outcome in their favor despite technology leakage and do not have to resort to such strategies. For example, Das (1987) presents a model in which native firms may learn from the subsidiary of a multinational firm who acts as a dominant firm facing a local competitive fringe in the product

[30] The industrial organization literature on market structure and innovation does not provide an unambiguous answer to this question either. A rough conclusion is that a monopolist has a stronger incentive to invest in R&D that yields innovations that complement existing technology whereas competitive firms have a stronger incentive to invest in R&D that results in innovations that replace existing technology.

market.[31] Assuming the rate of increase in efficiency of the local firms to be positively related to the scale of operation of the multinational firm's subsidiary, Das (1987) investigates the optimal time paths of the multinational's output and price. She shows that despite technology leakage, the multinational may find it profitable to transfer technology.[32]

Since the demonstration effect argument is largely an industry-level argument, relating industry level variation in R&D expenditures by local firms to the extent of FDI is one method of checking whether local adoption efforts are encouraged via FDI. Of course, such an exercise would have to control for the effect of FDI on market structure and this seems rather difficult. To the best of my knowledge, a convincing empirical exercise of this type has not been performed. Instead, the existing literature has focused on the effects of FDI on total factor productivity in local firms. We turn to this next.

4.2. Empirical evidence on spillovers

Early efforts in search of spillovers from FDI proceeded by relating the inter-industry variation in productivity to the extent of FDI. Examples of this research are Caves (1974), Globerman (1979), Blomström and Hakan (1983), and Blomström (1986). By and large, these studies find that sectors with higher level of foreign involvement (as measured by share or labor force in the industry employed by foreign firms or the extent of foreign ownership), tend to have higher productivity, or higher productivity growth, or both. The fact that these studies involved data from different countries (Australia for the Caves study, Canada for Globerman, and Mexico for Blomström) lends a strong degree of robustness to this positive correlation between the level of foreign involvement and productivity in a sector. Of course, the trouble is that correlation is not causation and as noted by Aitken and Harrison (1999), this literature may have overstated the positive impact of FDI on productivity in the host country. Investment may have been attracted to the more productive sectors of the economy instead of being the cause of the high productivity in such sectors. In other words, past studies may have ignored an important self-selection problem.

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[31] A related model is presented in Wang and Blomstrom (1992). In their duopoly model with differentiated goods, a multinational transfers technology to its subsidiary given that the local firm can learn from the new technologies introduced. Learning occurs both through costless technology spillovers (as in the contagion effects first emphasized by Findlay, 1978) as well as through costly investments made by the local firm. The most interesting implication of the model is that technology transfer via FDI is positively related to the level of the local firm's learning investment. This result suggests that multinationals respond to local competition by introducing newer technologies faster.

[32] Huizinga (1994) models a multinational's incentive for technology transfer where it faces risk of competition caused by expropriation by the host country government. The main result is that the

Both trade and FDI, help ensure an efficient allocation of global resources by encouraging investment in those sectors in which an economy enjoys comparative advantage. In this sense, the point noted by Aitken and Harrison (1999) is almost necessarily implied by traditional trade theory, unless trade protection encourages investment in sectors in which a host economy does not enjoy comparative advantage, in which case it may very well be welfare reducing.

Nevertheless, only with plant level studies can one control for the self-selection problem that might plague previous industry level studies. However, even this does not settle the issue. A self-selection problem may also plague plant level studies: the more productive plants may be the one's that attract foreign investment.[33] Nevertheless, if plant level studies *fail* to find a significant relationship between foreign involvement and productivity, the self-selection problem cannot be important, unless the argument is that foreign firms seek out plants with low productivity and then bring them up to par with other, more efficient local firms so that in the end, no significant productivity differential between foreign and local firms is found! This argument may be far-fetched but could make sense as follows. Suppose local plants with very low productivity are relatively under-valued by local agents since the skills (technology, modern management etc.) needed to bring them up to speed are in short supply locally. In such a scenario, such plants would be attractive to foreign investors who may be able to generate productivity improvements that simply cannot be achieved by local agents.

What do empirical plant level studies find with respect to spillovers from FDI? The first study to employ a comprehensive data set at the level of the individual firm over several years was Haddad and Harrison (1993). The data for this study came from an annual survey of all manufacturing firms in Morocco. The most fundamental result of this study was that foreign firms exhibit higher levels of total factor productivity (TFP) but their rate of TFP growth was *lower* than domestic firms. As the authors note, at first glance, such a finding suggests that perhaps there was some sort of convergence between domestic and foreign firms. However, this was not the case. While there was a *level effect* of foreign investment on the TFP of domestic firms, such an effect was missing for the growth rate of TFP of domestic firms. Secondly, when sectors were divided into high and low tech, the effect of FDI at the sectoral level was found to be more positive in low-tech sectors. The authors interpret this result as indicative of the lack of absorptive capacity on the

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multinational responds to this risk by lowering the quality of technology transfer even when such transfers are costless.

[33] A recent paper by Clerides et. al. (1999) finds support in favor of the self selection hypothesis in the context of exporting: it is the more productive firms that self select into exporting.

part of local firms in the high-tech sector, where they may be further behind multinationals and unable to absorb foreign technology.

Another attempt to measure spillovers from FDI was undertaken by Aitken, Harrison, and Lipsey (1996). This study approached the issue of technology spillovers from FDI through the labor market. The idea was that technology spillovers should increase the marginal product of labor and this should show up in the wages for workers. The study employed data collected from surveys of manufacturing firms in Venezuela, Mexico, and the United States. For both Mexico and Venezuela, a higher share of foreign employment was associated with higher overall wages for both skilled and unskilled workers. Furthermore, royalty payments were also highly correlated with wages. Most importantly, there was *no positive impact* of FDI on wages of workers employed by domestic firms. In fact, the authors report a small a negative effect and finally, the overall effect (for the entire industry) was positive. These findings are to be contrasted with those for the United States, where a larger share of foreign firms in employment was associated with both a higher average wage as well as higher wages in domestic establishments.

When the findings of the second study are put into the context of previous work, it is clear that wage spillovers (from foreign to domestic firms) are associated with higher productivity in domestic plants. Conversely, absence of wage spillovers appears to accompany the existence of productivity differentials between domestic and foreign firms. Why might this be so? Any serious explanation of this association requires that the one must study the interaction of the market for labor and goods. Glass and Saggi (1999) develop a model to capture this interaction and their findings are discussed in the sub-section on labor turnover below.

The most recent study on the issue of spillovers from FDI is Aitken and Harrison (1999). This study uses annual census data on over 4000 Venezuelan firms. Since each plant was observed over a period of time, the self-selection problem inflicting past sectoral level studies (i.e. FDI goes to the more productive sectors) could be avoided. The authors found a positive relationship between foreign equity participation and plant performance implying that foreign participation does indeed benefit plants that receive such participation. However, this own plant effect was robust for only small plants i.e. those plants that employed less than 50 employees. For larger plants, foreign participation resulted in no significant improvement in productivity relative to domestic plants. More interestingly, productivity in domestic plants *declined* when foreign investment increased. In other words, they found evidence of negative spillovers from FDI and suggested that such negative spillovers could result from a market stealing effect: foreign competition may have forced domestic

firms to lower output and thereby forgo economies of scale. Note that if loss in output is large enough, local plants may have lower productivity despite enjoying some sort of technology spillovers. Nevertheless, on balance, the authors found that the effect of FDI on the productivity of the entire industry was weakly positive. They also noted in a footnote that similar results were obtained for Indonesia except that the positive effect on own plants was stronger whereas the negative effect on domestic plants was weaker, suggesting a stronger overall positive effect for Indonesia's case.

In a recent paper, Djankov and Hoekman (1999) also found a negative spillover effect of FDI on purely domestic firms in Czech industry. Interestingly, however, when joint ventures were excluded from the sample and attention was restricted to the impact of majority-owned foreign affiliates (i.e., FDI) on *all* other firms in an industry (including joint ventures), the negative effect lost statistical significance. The authors report that survey questionnaires reveal that joint venture firms invested significantly more in new technologies than purely domestic firms did. The authors suggest that purely domestic firms might have lacked the ability to absorb the technologies introduced by foreign firms (due to their lower R&D efforts).

Overall, several studies have cast doubt on the view that FDI generates positive spillovers for local firms. But such findings need not imply that host countries have nothing significant to gain (or must lose) from FDI. The point is that reallocation of resources that accompanies the entry of foreign firms may not be immediate. Domestic firms should be expected to suffer from an increase in competition; in fact part of benefit of inward FDI is that it can help weed out relatively inefficient domestic firms. Resources released in this process will be put to better use by either foreign firms with superior technologies, or efficient new entrants (both domestic and foreign), or by some other sectors of the economy. Existing studies of spillovers may not cover a long enough period of time to be able to accurately determine how FDI affects turnover rates (entry and exit). Furthermore, such horizontal studies are further limited by design since they cannot clarify linkages and spillovers that may result from FDI in industries other than the one in which FDI occurs (see more on this below). Before considering this issue, we discuss what is perhaps a crucial channel of internal technology diffusion but has failed to receive much attention in the literature.

4.3. Labor turnover

While direct imitation and reverse engineering have been extensively studied as channels of inter-firm technology diffusion, the role of labor turnover has been rather neglected. Labor turnover differs from these channels because knowledge embodied in workers moves across firms only

through the physical movement of workers. The relative importance of labor turnover is difficult to establish for obvious reasons: one needs to track individuals who have worked for multinationals regarding their future job choices and *then* determine their impact on the productivity of new employers. Thus, there exist few empirical studies that attempt to measure the magnitude of labor turnover from multinationals to local firms. To the best of my knowledge, there exist *no* empirical studies that attempt to measure the role such turnover plays in improving productivity in local firms.

The available evidence on labor turnover itself is mixed. For example, while a study of Kenyan industries by Gershenberg (1987) finds limited evidence of labor turnover from multinationals to local Kenyan firms, several other studies document substantial labor turnover from multinational to local firms. The *World Investment Report* of 1992 discusses the case of Bangladesh's garment industry in some detail (see also Rhee, 1990). Korea's Daewoo supplied Desh (the first Bangladeshi firm to manufacture and export garments) with technology and credit.[34] Eventually, 115 of the 130 initial workers left Desh to set up their own firms, or to join other newly established, garment companies. The remarkable speed with which the former Desh workers transmitted their know-how to other factories clearly demonstrates the role labor turnover can play in technology diffusion.

Pack (1997) also discusses evidence documenting the role of labor turnover in disseminating technologies of multinationals to local firms. For example, in the mid 1980s, almost fifty percent of all engineers and approximately sixty three percent of all skilled workers that left multinationals, left to join local Taiwanese firms. On the other hand, the figures reported in the Gershenberg study of Kenyan industry are smaller: of the ninety one job shifts studied, only sixteen percent involved turnover from multinationals to local firms.

How does one synthesize these empirical findings? In other words, the cross-country variation in labor turnover rates *itself* requires an explanation. One possible generalization is that in countries such as South Korea and Taiwan, local competitors are less disadvantaged relative to their counterparts in many African economies thereby making labor turnover possible. Thus, the ability of local firms to absorb technologies introduced by multinationals may be a key determinant of whether or not labor turnover occurs as a means of technology diffusion in equilibrium.[35] This is

[34] Thus Desh was not a multinational firm in the strict sense; rather it was a domestic firm that benefited substantially from its connection with Daewoo.

[35] Local investment climate may be such that workers looking to leave multinationals in search of new opportunities (or other local entrepreneurs) find it unprofitable to start their own companies implying the

the argument advanced in Glass and Saggi (1999b). The rationale of their model is as follows. Since superior technology is one of the key intangible assets that permit multinationals to successfully compete with local firms, multinationals have an incentive to limit diffusion of their technology to local rivals. An effective method of limiting technology diffusion is to curtail labor turnover by offering higher wages than local rivals offer. Thus, if multinationals are observed paying higher wages than local firms are, the wage premiums paid by a multinational can provide a rough estimate of the value it places on the knowledge it transfers to its workers. The more interesting point is that such a premium may either exceed or fall short of the benefit the local economy would enjoy, if the multinational were to sit back and allow its workers to leave. Note that if the multinational must raise wages if it wants to restrict technology diffusion to local firms and the wage premium has no necessary relation to the social value of the knowledge embodied in workers, technology diffusion is not necessarily optimal for the local economy. Thus, policies designed to encourage technology transfer do not always raise welfare of the recipient country.[36]

Local competition policy may also effect labor turnover. For example, according to Bulgaria's competition law, no person is permitted to join the management of a competing firm operating in the same line of business as the person's original employer for the first three years after leaving an enterprise (see Hoekman and Djankov, 1997). Of course, in many industrialized countries, trade secrets laws protect firms against the loss of valuable information to their rival firms. But it is difficult to see how such laws can protect against the kind of basic technology diffusion that results from labor turnover from multinationals in developing countries.

Labor turnover rates may vary at the industry level as well. Casual observation suggests that industries with a fast pace of technological change (such as the computer industry in Silicon Valley) are characterized by very high turnover rates relative to more mature industries. So cross-country variation in labor turnover from multinationals could simply stem from the global composition of FDI: developing countries are unlikely to host FDI in sectors subject to rapid technological change.

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only alternative opportunity is to join existing local firms. The presence of weak local competitors probably goes hand in hand with the lack of entrepreneurial efforts since both may result from the underlying structure of the economic environment.

[36] It is worth relating these results to those of Das (1987) whose investigation of the effects of technology transfer reveals that local firms may lose from such transfers even though the local economy does not.

4.4. Vertical linkages and technology transfer

For quite some time now, it has been recognized that multinationals may benefit the host economy via the backward and forward linkages that they generate. However, merely documenting extensive linkages between multinational and local suppliers or buyers is insufficient to argue that net benefits accrue to the local economy as a result of FDI. Rodriguez Clare (1995) develops a formal model of linkages and shows that multinationals improve welfare only if they generate linkages over and beyond those generated by local firms they displace. Yet, the question of relevance here is whether the generation of linkages is expected to result in technology diffusion.[37] While analytical modeling of such issues is scarce, there does exist limited empirical evidence in support of the view that multinationals are involved in vertical technology transfers (Lall, 1980). Even more interesting is the possibility that such vertical transfers, when accompanied with spillovers, may lead to interaction between upstream and downstream multinational firms that encourages industrial development.[38]

In a recent paper, Pack and Saggi (1999) emphasize that downstream buyers in developed country markets will benefit from technology diffusion among potential suppliers in developing countries since such diffusion increases competition among suppliers. In their model, by increasing demand in the downstream market, competition caused by technology diffusion in the developing country market may induce entry into marketing thereby increasing competition in the downstream market.[39] While they do not model FDI, it is not hard to see how their model can be applied to understand the consequences of technology diffusion under FDI rather than exporting.

4.5. Spillovers from FDI: a recapitulation

A difficult challenge facing the optimistic view regarding technology spillovers from FDI is to explain how such spillovers can *ever* be in the interest of the multinational firms. Clearly, under most circumstances, multinationals would rather limit diffusion in the local economy. In fact, the heart of the theory that seeks to explain the emergence of multinationals is that such firms are able to successfully compete with local firms precisely because they possess superior technologies, management, and marketing. Why then would multinationals not take actions to ensure that such

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[37] Thus, we stay clear of the rather large literature on linkages that does not explicitly deal with the question of technology diffusion.

[38] See Markusen and Venables (1999) for a model that abstracts from technology spillovers and considers the pecuniary externalities that accompany vertical linkages and result in industrial development.

[39] One implication of their analysis is that fully integrated multinational firms may be more averse to technology diffusion than firms that are involved in international arms length arrangements since they have little to gain from diffusion.

advantages do not diffuse to local competitors? Part of the answer must lie in the fact that such actions are costly and may even entail externalities between multinationals. Suppose a costly action (such as litigation in local courts to enforce IPR protection) can indeed help limit loss of knowledge capital for a multinational. A difficulty arises if all potential multinationals benefit from the curtailment of technology diffusion whereas the costs fall on only the one who takes legal action. Thus, the public good nature of such actions suggest that developing countries hosting multinationals may expect the rivalry amongst such firms to indeed result in some degree of technology diffusion. Of course, the preceding argument also overstates the case a bit: some loss of knowledge will result despite all precautions. Nevertheless, the general message is clear: multinationals can take actions to limit diffusion, and while making their decisions regarding where to set up subsidiaries, the expected costs of technology diffusion will enter their calculus of profit maximization.

That being said, entry of multinationals may indeed be beneficial for host countries even though it fails to result in much in the way of spillovers for local firms. In fact, the preceding discussion suggests that spillovers to local firms that directly compete with the multinational would indeed be the most elusive of benefits that host countries may expect to enjoy from FDI. Second, the very act of curtailment of spillovers, may sometimes imply that local agents other than domestic competitors of multinationals (for example local workers) may enjoy positive externalities from FDI. If so, the total welfare effect of FDI on local welfare may be positive despite the lack of technology spillovers.

Lastly, we should note that spillovers may be of an entirely different nature: some empirical evidence indicates that multinational firms who penetrate foreign markets reduce entry costs for other potential exporters (see Aitken, Hanson, and Harrison, 1997).[40] Such spillovers may result from informational externalities and are more likely to lower fixed costs rather than marginal costs of production.

4.6. FDI and growth

Regardless of the channel through which technology spillovers occur, the fact that FDI often involves capital inflows along with technology transfer implies that one would expect a positive impact of FDI on growth in the host country. Yet there are several important caveats to this assertion. First of all, a positive correlation between the extent of FDI and economic growth in cross-country regressions may simply reflect the fact that FDI is attracted to countries that are

expected to grow faster simply because it yields higher returns there. Thus, the causation could run from growth to FDI and simultaneous equation system estimation may be needed to resolve the issue. Second, multinationals often raise the required capital in the host country and in such a scenario, capital inflows associated with FDI may not be substantial. An optimistic view of FDI would then look to technology transfer and/or spillovers as the mechanism through which FDI may affect growth.

In a recent paper, Glass and Saggi (1999a) examine the question of spillovers from FDI in a product cycle model. In their North-South model, the demonstration/proximity argument is formalized as follows: Southern firms are assumed to be able to imitate multinationals located in the South at a lower cost than firms located in the North. However, as they point out, multinational firms are also stronger competitors than firms that produce only in the North since multinationals produce in the same low wage location as potential imitators. Their model delivers the surprising result that a faster flow of FDI increases the aggregate rate of technology transfer to the South only if local firms lack the ability to imitate firms located in the North (i.e. if geographical proximity is a pre-requisite for imitation). If firms in the North can be imitated, FDI does not alter aggregate technology transfer since imitation focusing on firms located in the North slows down with a hastening of imitation targeting multinationals.[41]

In a recent, comprehensive paper, Borensztein et. al. (1998) utilize data on FDI flows from industrialized countries to sixty nine developing countries to test the effect of FDI on growth in a cross-country regression framework. Their findings are as follows. First, FDI contributes *more* to domestic growth than domestic investment, suggesting that it is indeed a vehicle of technology transfer. Second, FDI is more productive than domestic investment only when the host country has a minimum threshold stock of human capital. The latter finding is especially interesting since it clarifies when exactly FDI should be expected to effect growth.

Using cross section data from forty six developing countries, Balasubramanyam et. al. (1996) also investigate the effect of FDI on growth in developing countries. They report two main findings. First, growth enhancing effects of FDI are stronger in countries that pursued an policy of export promotion rather than import substitution, suggesting that the trade policy regime is an important determinant of the effects of FDI. Second, they find that, in countries with export promoting trade regimes, FDI has a stronger effect on growth than domestic investment. Both

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[40] Needless to say, our discussion of vertical technology transfer is also relevant here.

[41] Note that the model assumes that imitation of multinationals is always feasible; in this sense, a threshold level of absorptive/imitative capacity is assumed on the part of Southern firms.

findings relate well to the results of Borensztein et. al. (1998). The second finding may be viewed as a confirmation of the hypothesis that FDI results in technology transfer.

The findings of Borensztein et. al. (1998) relate well to Keller (1996) who argues that mere access to foreign technologies may not increase growth rates of developing countries. In his model, if a country's absorptive capacity (stock of human capital) remains unchanged, a switch to an outward orientation does not lead to a higher growth rate.[42]

Xu (1999) provides yet another confirmation of the argument that, in the absence of adequate human capital, technology transfer from FDI may fail to increase productivity growth in the host country. Using date on outward FDI from the United States to forty countries, Xu (1999) finds that technology transfer from FDI contributes to productivity growth in developed countries *but not* in lesser developed countries because the latter lack adequate human capital. Incidentally, as Xu (1999) notes, FDI may contribute to productivity growth due to reasons other than technology transfer. Thus, a statistically significant coefficient on some measure of FDI in a productivity growth equation does not necessarily imply that technology transfer is the mechanism through which FDI contributes to productivity growth. Xu measures the technology transfer intensity of MNE affiliates by their spending on royalties and license fees as a share of their gross output and estimates that of the total effect of trade (via R&D spillovers) and FDI (via technology transfer) on productivity growth in developed countries, forty one percent is due to technology transfer. [43] Xu's results for developed countries confirm the findings of Barrell and Pain (1997) who find that FDI has a positive impact on technological change in West Germany and United Kingdom.

5. The role of policy

[42] Using a model quite different from that of Keller's, Glass and Saggi (1998) focus on the issue of the quality of technology transferred via FDI. They argue that investment in imitation by host country firms generate the necessary knowledge (or skill) foundation for FDI, and thus factors that promote imitation can promote a higher quality mix of FDI. While Keller's model stresses that a country's stock of human capital effectively constrains its ability to take advantage of foreign technologies, Glass and Saggi (1998) emphasize that indigenous technological capability in an industry effectively constrains a country's ability to host foreign technology. Thus the latter paper takes a more disaggregated view of the constraints on technology transfer relative to the former although they make similar points. For example, a country may have a fair amount of human capital in the aggregate but may lack the technological sophistication in any particular industry to be able to host high quality FDI.

[43] In an earlier paper, Xu and Wang (1999) study the role of capital goods trade in generating R&D spillovers in OECD countries.

What does existing literature tell us about the role policy plays in process of international technology transfer? Clearly, the range of policies that can be considered is rather large. We restrict attention to trade, FDI, and IPR policy.

5.1. Trade policy

While the literature on trade policy is voluminous, the interaction between protection and technology transfer has not received significant attention. In fact, most existing models, treat the process of technology transfer in a rather rudimentary way and have focused instead on other aspects of the problem that are interesting in their own right, but not of central concern for this paper. Below, a few prominent examples of this line of research are discussed.

Miyagiwa and Ohno (1995) examine a domestic firm's incentives for technology adoption given the existence of a superior technology that has already been adopted by a foreign rival. The cost of adoption is assumed to decline over time and the main interest is in examining how the nature (tariff versus quota) and the duration (temporary versus permanent) of trade protection influence the domestic firm's incentive for technology adoption. The most interesting result in the paper is that temporary protection (i.e. protection that is removed upon successful adoption by the domestic firm) actually delays the date of technology adoption.[44]

The literature has also investigated the effect of trade protection in models of R&D based models of endogenous growth (Grossman and Helpman, 1991 and 1995, are excellent references). As can be expected from models in which increasing returns, imperfect competition, and externalities play a central role, results depend upon the details of a particular model and require careful interpretation. To the extent one can draw a general conclusion from such a complex literature, it is that the literature does *not* provide an unconditional argument against trade protection. As emphasized in section 2, conclusions hinge dramatically on the scope of knowledge spillovers: international knowledge spillovers strongly tilt the balance in favor of free trade whereas national spillovers create a role for policy intervention that can combat path dependence resulting from historical accident. For example, if productivity improvements depend only upon a country's own R&D, a case can be made for policies that ensure that industries in which such improvements occur at a rapid rate are not all located elsewhere.

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[44] In a related paper, Miyagiwa and Ohno (forthcoming), show that if temporary protection is credible, it may indeed increase R&D relative to free trade. On the other hand, if the domestic firm expects that protection will be removed early should innovation occur before the pre-announced terminal date of protection, it invests less in R&D under protection relative to free trade. Similarly, as first emphasized by

In a recent interesting paper, Dinopoulos and Segerstrom (forthcoming) develop a specific-factor variant of the `quality ladders' model of endogenous growth without scale effects and examine the consequences of contingent protection (tariffs imposed on imports whenever domestic firms lose their technological leadership to foreign firms who successfully innovate over them). Their approach is interesting because protection in the real world is usually not marginal (for example, antidumping duties may be levied on foreign firms with the explicit goal of providing *sufficient* relief to domestic industry). Somewhat interestingly, they find that tariffs that allow domestic firms to capture the domestic market are positively related to the global rate of technological change in the short run.[45]

5.2 FDI Policies

There is no simple way of describing the policy environment that faces multinationals in developing countries today and indeed this has almost always been the case. In countries that historically emphasized import substituting industrialization such as most of Africa, Latin America, and Southeast Asia, FDI was either completely prohibited or multinational firms had to operate under severe restrictions. Restrictive FDI policies were often pursued within the context of a larger strategy of import substitution and a central goal of such policies was to encourage the development of local firms. In fact, even in countries where technology acquisition was a major policy objective, multinationals were rarely permitted to operate wholly owned subsidiaries: Japan, Korea, and Taiwan all imposed restrictions on FDI at various points in time. In other words, `outward oriented' economies were *not* particularly keen on allowing multinational firms into their markets. The Ministry of International Trade and Investment (MITI) played an active role in Japan's acquisition of foreign technology. It limited competition between potential Japanese buyers, did not allow inward FDI until 1970, never greatly liberalized it, and even insisted at times that foreign firms share their technology with local firms as a precondition for doing business in Japan.

Matsuyama (1990), if the domestic firm expects protection to be extended in case of no innovation by terminal date, its investment incentives are marred by protection.

[45] Grossman and Helpman (1991) also analyze the effects of tariff protection in a two-country quality ladders model. However, unlike Dinopoulos and Segerstrom, they only analyze tariffs that are too small to allow domestic firms to capture the market. Both models assume Bertrand competition on the product market so that a low quality firm can monopolize the market only if a tariff of sufficient magnitude is imposed on higher quality imports. A small tariff can extract rents from foreign firms but fails to protect domestic firms who have been innovated over by foreign firms. It should be noted that Dinopoulos and Segerstrom's analysis assumes that both countries adopt symmetric.

[46] In contrast to the restrictive stance toward FDI, licensing of foreign technology was aggressively encouraged (Layton, 1982). South Korea's experience has also been quite similar.[47]

What, if any, is the rationale behind policies that discourage FDI? Pack and Saggi (1997) argue that by prohibiting FDI and placing other restrictions on the conduct of multinationals, government policies in many countries may have effectively weakened the bargaining position of foreign firms. They note that in Japan, MITI actively restricted many local firms from participating as potential buyers for this reason. But why treat technology licensing more favorably relative to FDI? Saggi (1999) suggests that the answer to this may have something to do with encouraging technological development of indigenous firms.[48]

Sometimes policy has also favored joint ventures relative to wholly owned subsidiaries of multinationals.[49] Why might this be so? Of course, an immediate possibility is that all such policies simply reflect protectionism: large public firms or hitherto protected private firms may not be able to compete with multinationals and are able to secure protection through the political process. However, is it also possible that joint ventures (as well as technology licensing) lead to more local involvement and therefore greater technology spillovers to local agents? Blomström and Sjoholm (1999) address this question in a recent empirical paper. Using plant level data for 1991 for all Indonesian establishments with more than 20 employees, this study focuses on two main questions. First, do establishments with minority and majority ownership (i.e. joint ventures versus wholly owned subsidiaries) differ in terms of their (labor) productivity levels? Second, does the degree of technology spillovers vary with the extent of foreign ownership? Clearly, the second question is crucial for our purposes. The results of this study are interesting. First, as in many other previous

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[46] Ozawa (1974) provides a rich description of the role imported technology and local R&D (aimed at facilitating absorption of foreign technology) played in Japan's economic development.

[47] For example, while annual inflows of licensed technology increased steadily during the 70s and 80s, FDI inflows into South Korea, which were always relatively low, stagnated during 1978-1983 whereas annual inflows of licensed technology as measured by royalty payments increased steadily during the 70s and 80s (Sakong, 1993). This slowdown of FDI into South Korea was partially a result of restrictive FDI policies instituted by the Korean government during that period. See also Hobday (1996) for further details on South Korea's experience.

[48] This paper develops a two-period model where a foreign firm chooses between FDI and technology licensing. The key assumption is that licensing results in greater transfer of know-how to the local firm than does FDI, under which it must compete with the subsidiary of the multinational firm. The main result is that the local firm would have the strongest incentive for innovation if the foreign firm were to follow initial licensing by direct investment. However, in equilibrium, the foreign firm never adopts such a course of action. Therefore, the model provides some insight into the frequently expressed preference for licensing over direct investment.

[49] The Chinese government has been particularly interventionist in technology transactions and has encouraged FDI in the form of joint ventures. While wholly owned subsidiaries are not prohibited, the policy environment favors joint ventures over such enterprises.

studies, labor productivity is found to be higher in establishments with foreign equity than in purely domestic firms. Second, the extent of total foreign production is positively associated with productivity of domestic firms, suggesting some sort of spillovers from FDI. And third, the degree of foreign ownership does *not* seem to affect either the productivity of firms that get foreign equity or the extent of spillovers to the domestic sector. Thus these findings do not support the hypothesis that joint ventures differ substantially from wholly owned subsidiaries. Yet the findings are puzzling: clearly the degree of foreign participation seems to matter in that plants with *no* foreign investment are less productive. Perhaps, the results suggest some sort of threshold effects, beyond a certain degree of foreign ownership, additional foreign equity does not affect productivity or spillovers.[50]

As noted earlier, the work by Djankov and Hoekman (1999) also uncovers an interesting role for joint ventures and suggests that such enterprises may have greater ability to absorb foreign technologies than purely domestic firms. Hoekman and Saggi (1999) suggest that, while the motivation behind policies that discriminate between licensing, joint ventures, and establishment of wholly owned subsidiaries is not easy to decipher, a plausible interpretation may be that such policies seek to maximize technology transfer to local firms while limiting the rent erosion that results from the entry of multinational firms.

To take another policy issue, many South-East Asian countries still do not allow free entry of multinational firms and often express preferences with regard to the *type* of FDI: entry by Pepsi or Coke is viewed differently from entry by GM or Texas Instruments. Unfortunately, there is little in the literature that helps us understand such policies. Other than the standard argument that certain industries are able to secure greater protection for themselves than others, perhaps it may also be the case that spillovers to the local economy are higher under certain types of FDI than others.[51] The latter argument is closely related to the idea of industrial targeting in general and the pitfalls of the government being able to correctly identify `high spillover' industries are all too well known to need further discussion here.

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[50] The authors do not report the minimum level of foreign equity (for those plants that do get foreign equity) in their sample. Also, one must keep in mind that the study only measures labor productivity and treats some important endogenous variables as exogenous. Overall, it seems fair to say that the question remains an open one. Several earlier studies (Mansfield and Romeo, 1980, for example) have documented that technologies transferred to wholly owned subsidiaries are of a newer vintage than licensed technologies or those transferred to joint ventures (see also Kabiraj and Marjit, 1995, and Saggi, 1996 for relevant theoretical models).

Despite the subtle policy interventions outlined above, when measured by a broad yardstick, overall government policy has become more liberal across the world. For example, as of 1997, there existed 1513 bilateral investment treaties among countries compared to 400 seven years earlier (UNCTAD, 1998). Economic reform in many formerly communist countries has added to the list of countries vying for FDI. Coupled with this rise in treaties is the proliferation of the use of fiscal and financial incentives in both industrialized and developing countries to lure in FDI. Such overly optimistic policies carry dangers of their own and may very well reduce welfare in host countries. While a case for such policies can indeed be made on the basis of positive externalities from FDI, as noted earlier, convincing evidence on this front is missing.[52]

5.3. Intellectual property rights protection

Common sense suggests that if any policy variable should affect international technology transfer, it ought to be the host country's intellectual property rights (IPRs) regime. The theoretical literature has investigated the affect of IPR enforcement on technology transfer and FDI in several endogenous growth models.[53] To limit the scope of the discussion, I omit models in which technology transfer does not play a central role. Several of the papers are linked via their use of the two models used intensively by Grossman and Helpman (1991). Before turning to these, I discuss the work of Taylor (1994) since it differs from the other papers in that it employs a model of endogenous technological change and transfer with Ricardian features. Taylor examines two scenarios: one in which IPR enforcement is symmetric (applies to innovators regardless of country of origin) across the two regions and one in which it is asymmetric (only domestic innovators are protected). While his analysis is conducted under the assumption of costless technology transfer and equal productivity in R&D in the two countries, his results hold even when both assumptions

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[51] One may speculate that domestic content protection policies for example hope to involve more local firms and therefore generate greater spillovers. However, there is no formal model or empirical evidence that supports this position.

[52] See Barry and Bradley (1997) for details regarding Ireland's experience with FDI. Both favorable policies (reduced taxes and trade barriers, investment grants etc.) as well as strong fundamentals (such as infrastructure, educated labor force etc.) seem to have played a role in attracting export-catering FDI to Ireland. The strong performance of the Irish economy since the mid-1980s is attributable to both strong fundamentals as well as significant FDI inflows into Ireland.

[53] In a strategic, partial equilibrium model, Vishwasrao (1995) argues that the lack of adequate enforcement of technology transfer agreements may encourage FDI relative to licensing. In her screening model, depending upon the type of the licensee, licensing may or may not lead to imitation. The trade-off between FDI and licensing is that FDI avoids risk of imitation at the expense of higher production costs.

are dropped making it possible to apply them to a North-South setting.[54] His major result is that asymmetric protection of IPRs distorts the pattern of both trade in goods as well as R&D and lowers the global rate of growth.

Interpreting the exogenous rate of imitation as a proxy for the level of IPR enforcement in the South, Helpman (1993) shows that a decline in the intensity of imitation promotes FDI (with innovation exogenous).[55] However, the major contribution of Helpman's work lies in providing the first detailed welfare analysis of IPR enforcement in the South (as measured by an exogenous decline in the rate of imitation) in a dynamic general equilibrium growth model. He shows that a strengthening of IPR protection is not in the interest of the South and that imitation may even benefit the North provided the rate of imitation is not too fast. Lai (1998) extends the Helpman model to allow for FDI and shows that innovation is promoted along with FDI. The common weakness of both models is that stronger IPR enforcement is modeled as an *exogenous* decline in the rate of imitation. Nevertheless, Helpman's model is a tour de force in that it specifies clearly the alternative channels via which a strengthening of Southern IPR protection affects world welfare.

In a recent paper, Yang and Maskus (1999) study the effects of Southern IPR enforcement on the rate of innovation in the North as well as on the extent of technology licensing undertaken by them. A key assumption in their model is that increased IPR enforcement increases the licenser's share of rents and reduces costs of enforcing licensing contracts, thereby making licensing more attractive. Consequently, both innovation and licensing increase with stronger IPR protection in the South.

The main contribution of Glass and Saggi (1999c) is that they treat stronger IPR protection as an *endogenous* decline in imitation due to increased imitation costs (stemming from stricter uniqueness requirements) where Southern imitation targets both multinationals producing in the South and purely Northern firms producing in the North.[56] They find that FDI actually decreases with a strengthening of Southern IPR protection because an increase in the cost of imitation crowds out FDI through tighter Southern resource scarcity. Less efficient imitation

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[54] A subtle qualification that must be made: symmetric versus asymmetric treatment implies both countries adopting one policy as opposed to another. Incentives for unilateral adoption of a symmetric policy are not analyzed in Taylor's model.

[55] Krugman (1979) addressed the issue as well, although his model had a greater degree of exogenity than Helpman's.

[56] While products like books, videos and CDs receive much press about conflicts over IPR protection, imitating most products is not so simple (see Pack and Westphal, 1986). Empirical evidence indicates that imitation is indeed a costly activity for a wide range of high technology goods, such as chemicals, drugs,

absorbs more resources despite the reduction in the rate of imitation due to the reduced profitability of imitation. Additionally, the contraction in FDI tightens resource scarcity in the North: increased production leaves fewer resources for innovation, so the rate of innovation falls.[57]

It is worth emphasizing that if strengthening of Southern IPR protection increases the cost of imitation targeting both firms producing in the North *as well as* multinationals producing in the South, Northern incentives for FDI (at the firm level) are basically unaffected. How does one reconcile this result with the positive effect of increased IPR enforcement on FDI frequently emphasized in empirical work (see Lee and Mansfield, 1996)? There are two ways out. First, increased IPR enforcement may be asymmetrical in that firms who invest in a country can expect to have a greater say in local courts relative to those that simply export. Second, imitation of firms located in the North may simply not be an option for host country firms (as may be the case for relatively poorer countries) so that any increased IPR enforcement affects only multinational firms.

As Ferrantino (1993) has noted, all of the preceding models suffer from a fundamental problem: either FDI *or* licensing is the only channel via which northern firms are allowed to produce in the South.[58] A more complete treatment of FDI requires that Northern firms be given the option of transacting in technology via they market. What are the consequences of strengthening IPR protection in the South if northern firms can choose between licensing and FDI? Does FDI increase with IPR enforcement or does such a policy change encourage licensing by lowering the risk of opportunism in market transactions? The latter scenario is equally likely and studies that completely ignore the possibility of licensing (or joint ventures for that matter) are likely to overstate the effect of IPR enforcement on inward FDI. In fact, a more subtle analysis may be needed. Increased IPR enforcement in the South may indeed make it a more attractive location for production (thereby increasing FDI relative to exports) but the technologies transferred for that purpose may flow through licensing rather than FDI so that the net effect on technology transfer via FDI is ambiguous. Of course, aggregate technology transfer to the South may very

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electronics and machinery. For example, Mansfield et al. (1981) find that the costs of imitation average 65 percent of the costs of innovation (and very few products were below 20 percent).

[57] All of these models do not study the interaction between optimal policies in the two regions. In a recent paper, Lai and Qiu (1999) attempt this task and show that the South's optimal IPR protection level is lower than that of the North. More importantly, global welfare may very well suffer if the South is forced to adopt the Northern standard.

[58] Maskus and Penubarti (1995) ignore FDI all together and study the effect of IPR regimes on trade. Using data for 1984, they ask whether the distribution of bilateral trade across nations depends upon the IPR regimes of importing countries. The find that within the group of large developing countries, stronger IPR regimes attract larger than expected flows of imports from OECD countries.

well increase, although general equilibrium effects may also require qualifications of this conclusion (Glass and Saggi, 1999c).

Using data for 1982 on US exports and sales of overseas affiliates of US firms, Ferrantino (1993) presents a detailed cross-country study that attempts to identify the determinants of both exports and sales of multinational affiliates of US firms, as suggested by the gravity model. His analysis reveals many insights but perhaps the most interesting finding is that the US exports more to its affiliates in countries that are non-adherents. Ferrantino (1993) suggests that this may reflect a desire to conceal information about the production process by confining production within the borders of the US. This interpretation fits well with a central idea theme of this paper: multinational firms will adjust their strategies to optimize against policies and market conditions they face in various host countries, casting doubts about the conclusions of empirical (or theoretical) work that treats FDI as given.

Empirical evidence also indicates that the level of IPR protection in a country also affects the composition of FDI in two different ways (Lee and Mansfield, 1996, Smarzynska, 1999b). First, industries in which IPRs are crucial (pharmaceuticals for example), firms may refrain from investing in countries a weak regime of IPR protection. Second, regardless of the industry in question, multinationals are less likely to set up manufacturing and R&D facilities in countries with IPR regimes and more likely to set up sales and marketing ventures, since the latter run no risk of technology leakage.

The above studies present useful findings but are unable to address perhaps the most central of questions: does a country's IPR regime affect its economic growth? While several theoretical analyses of this question exist, empirical studies are scarce. One such study is Gould and Gruben (1996). Using cross-country data on patent protection, trade regime, and economic fundamentals, these authors report that IPR protection, as measured by the degree of patent protection, is an important determinant of economic growth. Somewhat more interestingly, they report that the effect is stronger for relatively open economies than it is for relatively closed economies. In other words, a strengthening of IPR protection is more conducive for growth if it is accompanied by trade liberalization. A possible interpretation of this finding is that, by increasing foreign competition, trade liberalization not only curtails monopoly power granted by IPRs but also ensures that such monopoly power is obtained only if the innovation is truly global. If firms in

other countries can export freely to the domestic market and have better products or technologies, a domestic patent is quite useless in granting monopoly power.[59]

6. Conclusions

This paper has covered a rather large terrain. It is worth emphasizing the main points in easily digestible form:

- The role of trade in encouraging growth hinges critically on the geographical scope (national versus international) of knowledge spillovers. Empirical studies have not yet settled the issue; the truth may simply be that for developing countries, spillovers are even more national in scope than for industrialized countries. Consequently, whether R&D and high technology production is carried out in close geographical proximity to a country may indeed matter for development.
- Little is known about the relative role of trade and FDI (with licensing, joint ventures etc. as special cases) as mechanisms of technology transfer. Given that foreign firms opt to produce in a developing country, FDI seems to be the preferred route and is therefore a prominent channel of technology transfer.
- A well-developed paradigm (OLI) seeks to explain the emergence of multinational firms, given the existence of viable alternatives such as exports, licensing, and joint ventures. This is useful approach for explaining static issues. The dynamic choice between alternative modes has not been adequately explored even in theory, let alone data.
- Local policy frequently makes pure FDI infeasible forcing foreign firms to opt for licensing or joint ventures. Empirical evidence supporting the idea that the latter modes of technology transfer lead to more learning by local firms is scant or completely missing. To be fair, few careful studies have attempted this difficult task. So the jury may be still out.
- Policies designed to lure in FDI have proliferated in recent years. If the case for such policies rests on positive spillovers from FDI to domestic firms, then the case may be rather weak. Several recent plant level studies have failed to find positive spillovers from FDI to firms *competing* directly with subsidiaries of multinationals. However, these studies need a careful interpretation since they treat FDI as exogenous. Second, FDI spillovers may have a *vertical* nature rather than the *horizontal* nature assumed in such studies. Furthermore, all such studies find that the subsidiaries of multinationals are more productive than domestic firms. Thus, regardless of the evidence on the spillover issue, FDI does result in a more effective use of resources in host countries.
- Several studies (both theoretical and empirical) indicate that absorptive capacity in the host country is crucial for obtaining significant benefits from FDI. Without adequate human capital or investments in R&D, spillovers from FDI may simply be infeasible. In fact, this may be the most robust finding of the literature discussed in the paper. Thus, liberalization of trade and FDI policies may need to be complemented by appropriate policy changes with respect to education, R&D, and human capital accumulation, if developing countries are to take full advantage of increased trade and FDI.

[59] Using data from Mexican manufacturing firms, Tybout and Westbrook (1995) find that trade liberalization was associated with higher rates of productivity growth.

- IPR policy may alter the composition of FDI both at the industry level as well as the firm level. Industries in which IPRs are crucial, firms may refrain from FDI if IPR protection is weak in the host country or they may not invest in manufacturing and R&D activities. Lastly, IPR policy may also affect the mode of technology transfer (licensing, joint ventures, or establishment of wholly owned subsidiaries).

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