FDI & innovation, imitation

Following successful innovation of a new process or product technology, production can be shifted abroad through a variety of channels: firms can license their technologies to foreign firms, undertake foreign direct investment (FDI), or may find that their technologies are transferred abroad through imitation by foreign firms. With FDI, the incumbent firm establishes a plant in another country, whereas with imitation, production in the other country is done by a rival firm (or firms). This entry discusses the complex interactions between FDI, innovation, and imitation in the world economy: how FDI affects innovation, and how FDI affects imitation, as well as how innovation affects FDI, and how imitation affects FDI. The two main channels though which FDI is related to innovation and imitation are R&D incentives and resource availability.

FDI, innovation, and imitation each typically require the investment of resources. Most innovation results from intentional efforts to develop new varieties of products, higher quality levels of existing products, or lower cost methods of production (process improvements). These efforts require firms to bear significant costs with an uncertain outcome. While there may be some products for which imitation is straightforward, in most cases imitation, like innovation, is also a costly and uncertain activity. Mansfield et al (1981) finds that imitation costs average two-thirds of innovation costs for firms in the chemical, drug, electronics, and machinery industries. Undertaking FDI also incurs costs (prior to production), such as fixed costs of establishing new plants, adapting technologies to new economic environments, finding local suppliers, and the like.

Each of these activities – FDI, innovation, and imitation – must yield a reward in the form of an expected stream of profits sufficient to offset the initial costs or else firms

would have little incentive to undertake them. Properly discounted, the total expected profits from an innovation must at least cover the costs of generating the innovation for firms to be willing to invest resources in the innovation. As the costs of a successful imitation tend to be lower than for the original innovation, the profits of a successful imitator can be lower (or shorter in duration) than for an innovator, but again imitators need to rewarded, through the expected profits from a successful imitation, for their imitation expenses. For FDI, the expected profits must rise by enough to compensate for the up front costs of shifting technology abroad.

Additionally, these activities may be constrained by the availability of factors such as skilled labor. In countries where firms innovate, there must be enough resources for both R&D and production uses; in countries where firms imitate, there must be enough for imitation efforts, production by successful imitators, and production by multinational firms. Thus, FDI, innovation, and imitation are all affected by incentives and resource availability – the two key factors that determine practically all economic activity.

How FDI Affects Innovation

The costs of innovation need to be offset by the expected stream of profits from selling the product. As FDI is undertaken to enhance profits, it would seem that the opportunity to undertake FDI should accelerate innovation by enhancing the reward to innovation.

Suppose FDI involves shifting production to a lower cost location. If the opportunity to shift production abroad arrives at a higher probability, then the higher profits under FDI should begin sooner, all else equal. However, Glass and Saggi (1999)

show that the effect of faster arrival of exogenously given FDI opportunities on innovation is essentially zero when endogenous imitation targets production by multinational firms. The faster arrival of higher profits under FDI is offset by a shorter duration of profits before imitation, when FDI opportunities are beyond the control of firms.

Why then are FDI opportunities commonly believed to stimulate innovation? Perhaps FDI does not occur due to exogenous increases in opportunities to shift production abroad, but in response to other influences. Instead of a faster arrival of fixed FDI opportunities, suppose that FDI increases endogenously in response to variations in the underlying economic environment. For example, suppose the labor supply abroad increases to provide more labor for production there. In response, FDI increases to shift production from home to abroad, and innovation also increases, as shown in Glass and Saggi (2002). Other changes, such as a reduction in the difficulty of adapting technologies for production abroad, can also increase FDI and innovation. Crisuolo et al (2005) provides evidence that firms that are globally engaged do innovate more.

How FDI Affects Imitation

By shifting production abroad, FDI typically generates technology spillovers through demonstration effects. More can be learned about a technology when it is produced locally than when only the final product can be seen. While inspecting the final product can yield useful insights, full knowledge of the production process is hard to determine from the end result. However, when production occurs locally, workers at the multinational firm observe the production process first hand. Workers who have been

exposed to the technology, and perhaps specially trained, may leave the multinational to work for local firms or even start their own firms. Local suppliers of intermediates may also serve as sources of information. These knowledge flows act to lower the cost and difficulty of imitation. Hence, by reducing the cost of imitation, FDI should encourage imitation through incentive effects.

However, on the other hand, FDI vies with local production for local resources such as skilled labor. In some circumstances, FDI might deter imitation if multinationals bid up prices for scarce resources. Furthermore, when FDI is motivated by cost savings, multinationals have lower production costs than firms that export the good from elsewhere, so the profit margins earned when producing an imitation of a multinational's product should be less than that earned when producing an imitation of a product produced elsewhere. Due to the reduced profit margins for imitators, FDI could deter imitation. Glass and Saggi (1999) show that a faster arrival of opportunities to shift production abroad through cost-saving FDI can leave the aggregate rate of imitation essentially unchanged. So even though FDI makes imitation easier, there is no guarantee that FDI spurs local imitation.

How Innovation Affects FDI

Multinational firms need to possess an ownership advantage in order to overcome the inherent difficulties of operating in multiple countries. Innovation yields the technological expertise that often provides the source of ownership advantage for multinational firms. As innovation is, in a sense, a necessary precondition for FDI, innovation should spur FDI.

However, who is conducting the innovation matters. A firm doing more innovation should lead that firm to do more FDI. But to the extent that innovation is being done by rival firms, FDI may be deterred. Innovation by rivals poses a risk that the profit stream that rewards innovation may be terminated (or reduced) by a successful innovation by another firm.. In some industries, the existing leaders have significant advantages from successful past innovations and therefore have a greater incentive to innovate, whereas in other industries, firms are on more equal footing and innovation is spread across many firms. This distinction suggests that the relationship between innovation and FDI may differ across industries.

For the newest technologies, firms usually opt for FDI over licensing on account of large transactions costs that arise due to the presence of asymmetric information. At the moment when a new technology is first created, only the innovating firm is well informed about its key attributes. Thus, transferring such technologies to independent firms in other countries via arms-length contracts might be rather difficult since such firms would typically not have a reliable estimate of the value of the technology. Under such a scenario, the innovating firm might choose to undertake FDI by establishing a fully owned subsidiary as opposed to licensing the new technology to a foreign firm. By impeding arms-length contracting, transactions costs can induce internalization on the part of an innovating firm.

Furthermore, such internalization might also be motivated by strategic considerations: a firm may be unwilling to share its newest technologies with foreign firms who could become future competitors. It maybe difficult, or perhaps even impossible, to prevent a licensee from terminating the contract and undertaking

independent production after it has mastered the new technology. A further worry might be that a current licensee uses the technology to invent a future technology that makes it an even fiercer competitor. Both the transactions cost perspective and strategic considerations suggest that firms will typically transfer their newest technologies through FDI and relatively more mature, and less valuable, technologies through licensing and other arms length arrangements. A wealth of econometric and case-study evidence supports this hypothesis.

How Imitation Affects FDI

When FDI brings about higher profits through costs savings, imitation poses the risk that the enhanced profit stream under FDI will be terminated. Thus, imitation would seem to deter FDI. However, to determine how imitation affects FDI incentives, Glass and Saggi (2002) have argued that, as multinationals need not be the only firms targeted by imitation, the relative risk of imitation as a multinational must be compared to the imitation risk when producing back at home. Even though FDI lowers the cost of imitation, the profit margin earned by an imitator is lower when targeting the product of a multinational, when FDI lowers production costs. So there is reason for both types of imitation to exist: easier imitation targeting multinationals and more difficult imitation (that is more richly rewarded in terms of profits) targeting products produced elsewhere. When imitators target technologies regardless of whether FDI has occurred, increased risk of imitation need not deter FDI if the imitation risk also increases for firms who produce back in their home countries. What matters is how much more exposed to imitation multinationals are relative to firms that export. Glass and Saggi (2002)

demonstrate a tendency for the relative risk of multinationals to remain constant so that the increased risk of imitation as a multinational does not vary as many other parameters of the model change.

For example, if imitation becomes more difficult, the rate of imitation falls, which one might think would encourage FDI. But both imitation targeting multinationals and imitation targeting non-multinationals decrease, and they decrease in equal proportion, so that the relative imitation risk for multinationals is essentially unchanged. In addition, there are effects operating though the labor constraint: due to the increased difficulty of imitation, the labor needed for imitation can increase, even though imitation falls. The increased use of labor for imitation crowds out FDI, as there is less labor left for production by multinational firms. In this case, less imitation (due to increased difficulty) leads to less FDI.

Imitation can be thought to encourage FDI in some settings. Glass and Saggi (1998) construct a model with two types of FDI: FDI that transfers state-of-the-art technology and FDI using older technology. In that model, successful imitation of the older technology is required before FDI transferring state-of-the-art technology becomes feasible. The initial imitation is needed to establish a knowledge base in order for the technology transfer costs for the new technology to become reasonable. In this setting, while imitation of the latest technology could deter FDI, some initial imitation of older technologies is necessary for more advanced FDI to occur.

The impact of imitation on FDI can also depend on whether imitation changes exogenously or endogenously. Glass and Wu (2007) contrast the results for the effects of imitation on FDI when imitation changes exogenously or endogenously, as well as

depending on whether imitations are quality improvements or new varieties, and whether innovations are done by leaders or rival firms (followers). Mostly, imitation and FDI move together in quality ladders models, except when innovations are done by followers. Exogenous increases in imitation may decrease FDI when innovations are new varieties – see Helpman (1993) and Lai (1998). There are also models with R&D having decreasing returns to scale – see Dinopolous and Segerstrom (2005) and Sener (2006).

In sum, the interrelationships between FDI, innovation and imitation are quite complex. Claims that may seem obvious, such as that innovation spurs FDI or even that FDI spurs innovation, need not be generally true. Similarly, FDI need not spur imitation and imitation need not always deter FDI. Given the many possible scenarios uncovered by theory, there is a great need for empirical work to sort out which outcomes are predominant. A better sense of what is happening in the data will lead to a better understanding of how imitation, FDI and innovation matter to firms.

Further Reading

Crisuolo, Chiara, Jonathan E. Haskel, and Matthew J. Slaughter 2005. "Global Engagement and the Innovation Activities of Firms." NBER Working Paper No. 11479. Evidence that globally engaged firms innovate more.

Dinopoulos, Elias, and Paul Segerstrom. 2005. "Multinational Firms and Economic Growth." Mimeo. Compares effects of polices that encourage multinational firms to effects of globalization in the form of geographic expansion, in a scale-invariant growth model.

Glass, Amy J., and Kamal Saggi. 2002. “Intellectual Property Rights and Foreign Direct Investment.” *Journal of International Economics* 56(2): 387-410. Models the interrelationships between imitation, FDI, and innovation when imitation is endogenous and innovations are quality improvements.

Glass, Amy J., and Kamal Saggi. 1999. “Foreign Direct Investment and the Nature of R&D.” *Canadian Journal of Economics* 32(1): 92-117. Shows how exogenous increases in opportunities for cost-saving FDI affect imitation and innovation.

Glass, Amy J., and Kamal Saggi. 1998. “International Technology Transfer and the Technology Gap.” *Journal of Development Economics* 55(2): 369-98. A model of the connection between imitation, FDI, and innovation that distinguishes between the type of technology (new or old) transferred through FDI.

Glass, Amy J. and Xiaodong Wu. 2007. “Intellectual Property Rights and Quality Improvement.” *Journal of Development Economics* 82(2): 393-415. Models the interrelationships between imitation, FDI, and innovation when imitation is exogenous and innovations are quality improvements; contrasts with other findings.

Helpman, Elhanan. 1993. “Innovation, Imitation, and Intellectual Property Rights.” *Econometrica* 61(6): 1247-80. Models the effect of imitation on FDI when imitation is exogenous and innovations are new varieties.

Lai, Edwin L.C. 1998. “International Intellectual Property Rights Protection and the Rate of Product Innovation.” *Journal of Development Economics* 55(1): 133-53. Models the effect of imitation on FDI and innovation when imitation is exogenous and innovations are new varieties.

Mansfield, Edwin, Mark Schwartz, and Samuel Wagner. 1981. “Imitation Costs and Patents: An Empirical Study.” *Economic Journal* 91(364): 907-18. Collects data on imitation cost and time relative to innovations.

Sener, M. Fuat. 2006. “Intellectual Property Rights and Rent Protection in a North-South Product-Cycle Model.” Mimeo. Includes efforts by successful innovators to deter innovation and imitation by other firms.

Vernon, Raymond. 1966. “International Investment and International Trade in the Product Cycle.” *Quarterly Journal of Economics* 80(2): 190-207. The original product cycle model with FDI.

Amy Jocelyn Glass
Department of Economics, Texas A&M University

Kamal Saggi
Department of Economics, Southern Methodist University