Lecture # 19 – International Technology Policy

I. A Framework for Technological Progress in Developing Countries

- Drivers of technological progress (see figure 3.1)
    - Exposure to external flows (top) interacts with domestic capacity to diffuse technology
    - Absorptive capacity depends upon
        - Business and macroeconomic climate
            - Stable economic environment important, so that investors aren't worried about losing capital due to conflict, rapid inflation, or widely varying exchange rates
            - Banking system and equity markets are less developed in lower income countries
            - Makes it difficult for innovative firms to gain access to financing
        - Basic technological literacy &availability of advanced skills
            - Determine ability to implement, understand, and adjust to imported technologies
        - Policies to support innovative firms
            - Adaptive R&D may be necessary to adapt technology to local conditions
    - Increasing returns and spillovers can magnify these effects
        - Access to foreign markets allows firms to grow and potentially exploit economies of scale
    - Affordability of technologies is an issue
        - Financing constraints may be present in low-income countries
        - Adopting new technologies is risky
            - People with lower incomes likely to be more risk averse

II. Transmission Channels for Technology

A. Trade Policy

- Trade policy
    - Given the importance of trade for technology transfer, it follows that trade policy is also important.
        - Since mid-19990s, share of imported high-tech products in GDP has increased by 50% in low-middle income countries and 70 percent in middle income countries
    - Trade gives access to embodied technological change embodied in both capital and intermediate inputs
        - Allows firms to learn from and copy these technologies
        - Whether the productivity gains are a net gain to the country depends on how much companies pay for imported technology
    - Trade can be used to both substitute for and to compliment local capabilities.

        - When production capabilities do not exist locally, trade may involve a decision to rely on foreign capabilities rather than first develop them indigenously.
        - As the costs of imitation and copying fall, international patent and copyright protection becomes a more important issue.
    - Trade exposes firms to competition, which encourages innovation
        - Competition reveals the least cost methods of production
            - Need to keep up in able to compete
        - Firms can realize economies of scale by expanding production beyond what is needed to satisfy local markets
        - However, studies suggest selection bias relevant here
            - While most productive firms export, it isn't that exporting makes them productive, but that the export because they are productive
        - In addition to allowing free trade, conforming to world standards and regulations is important.
    - Policies encouraging increased exports have been more successful in increasing technological improvement.
        - Compare India and Korea.
            - India focused on inward growth strategies.
            - Korea did not use protectionist measures until a strong industrial base had developed.
        - Note, for example, that Korea granted subsidies based on export performance.
            - Firms were rewarded for entering export markets with preferential access to credit.
            - Initial focus (1960s) was on low-tech industries, but moved towards high-tech over time.
    - Liberal trade policy helps to promote FDI
        - Open trade policy attracts outward-oriented investment.
            - Of course, may or may not lead to spillovers.
        - Protectionist trade policy leads to FDI to avoid tariffs.
            - Typically older technologies, only competing with domestic producers.
            - Not competitive internationally.
- Examples of different strategies – imports and exports vary by stage of production
    - China
        - Focus on assembly
        - Strongly integrated into international segment-of-production processes
        - Most high-tech imports are parts and components, which are incorporated into exports
    - India
        - Limited participation in international segment-of-production processes

        - Low level of high-tech imports
        - High-tech exports concentrated in chemical industries
    - Turkey
        - High-tech imports are capital goods
        - Focus is on traditional technology transfer to upgrade local industrial capacity
        - Foreign trade focuses on Europe
- Counterexample: import substitution
    - Some developing countries try to limit dependence on imports by shifting resources from traditional export sectors to the production of goods they have imported.
        - Has been used in many Latin American countries.
    - The intuition is that, because of tacit skills, countries feel they cannot develop new technologies without experience.
        - By reducing dependence on global markets, import substitution strategies help insulate a developing country from fluctuations in global markets.
        - However, countries using import substitution strategies lose their comparative advantage.
        - Countries also lose the opportunity to import capital goods that may embody newer technology
    - The success of South Korea and Taiwan, who developed quickly with a heavy reliance on foreign trade, have made import substitution strategies less popular.
        - Note that Brazil did weaken restrictions on imported technology in the 1990s.
    - Example: computers in Brazil
        - During the mid-1970s, Brazil banned imports and FDI of computer products, in order to encourage development of a domestic computer industry.
        - Set up public research infrastructure to complement the industry.
        - Led to a large national industry by the mid-1980s.
            - However, this industry was inefficient.
            - Its prices were significantly higher than international competitors, and the computers were typically a generation behind the latest models.

B. FDI & Licensing

- FDI
    - Classification of FDI strategies (Soubbotina 2006, cited in WB)
        - "Traditionalist slow learners"
            - Rely on imports of machinery and equipment
            - Examples: Bangladesh, Burkina Faso
        - "Passive FDI-dependent"
            - Share of high and medium tech in manufactured exports higher than in manufacturing value added
                - Their high-tech exports depend on imports of technologically sophisticated components
                - Local focus is on assembly
                - Examples" Malaysia, Mexico, Philippines
        - "Active FDI dependent"
            - High-tech exports and high-tech value added similar
            - Examples: Chile, Hungary
    - Important features to attract FDI:
        - Infrastructure
        - Stable political, economic, and social environments
    - For technology transfer to occur, foreign subsidiaries must be linked to the national economy.
        - Compare, for example, maquiladoras in Mexico, which do not transfer much technology beyond the border region
    - As noted before, closed economies will not be attractive to export-oriented FDI (e.g. high tech)
    - In the early 1990's, China liberalized foreign joint venture laws to allow wholly-owned foreign enterprises
        - Much activity concentrated on coasts
        - Level of technology in country rising as a result of FDI and trade liberalization
        - Market forces have increased incentives for R&D at Chinese firms
            - R&D up 15%/yr from 1991-2002
            - R&D intensity: 1.3% of GDP in 2002
                - Just 0.7% in the late 1990s
    - FDI is concentrated in a few markets
        - Most in Latin America, least in South Asia
            - Not as high in East Asia in 2000s, because of financial crisis in late 1990s and because growth in FDI in China has not kept pace with GDP growth
        - More in middle income countries than low-income countries
            - Recall that host country must be attractive to the foreign investor
    - Factors influencing whether FDI leads to spillovers
        - Ability of upstream firms to provide needed products

        - Requirements to use local firms may discourage use of most advanced technology to avoid leakage
        - Absorptive capacity is important
            - Firms using advanced technology in low-income countries fail to achieve same level of productivity of those in middle- and high-income countries
        - Availability of local skills
            - In some countries, such as Mexico, FDI has not led to spillovers because primarily aimed at exploiting availability of low wage workers
        - Spillovers may be geographically concentrated
            - 90% of FDI in China goes to western coastal region
- Licensing
    - Has become an increasing source of transfer
        - Licensing fees paid by developing countries (5X increase as % of GDP):
        - 1999: $7 billion
        - 2006: $22 billion
    - Can be a substitute for FDI
        - Firms use when uncertain about policy environment
    - Some countries pursue licensing strategy so that domestic firms can learn from licensed technology
        - Japan in 1950s and 60s
        - Korean firms used licensing to negotiate access to underlying design principles of a technology (from older reading)
    - However, restrictive licensing depends on bargaining power.
        - Keep in mind that firms can go elsewhere
        - For example, Brazil historically capped royalty rates at around 5% The goal was to help firms bargain with foreign companies. The result, however, was that firms chose not to license technology in Brazil.
        - Later, Brazil was more successful

C. International Migration

- International migration
    - Migration is increasing
        - There are about 215 million first-generation migrants globally
            - 40% more than in 1990
        - Better communication and travel make staying in touch with home easier
    - Immigrants are a source of technology transfer
    - But, brain drain is a negative influence
        - Particularly a problem for smaller countries
    - Diaspora can be a source of skills and capital
        - Strengthen trade and investment linkages

        - Most FDI in China handled by Chinese diaspora
        - American firms employing more Chinese find it easier to set up operations in China without a joint venture
    - Help promote technology adoption at home
        - Partially through political pressure
    - Spread information about potential markets
    - Foster trust – leads to informal networks
        - More likely to work on international deals with someone of the same nationality
        - Trust particularly important in countries where the rule of law is uncertain
            - Personal ties important in such cases, as in the examples in the *Economist* article "Weaving the world together"
                - Example of Africans in China who help a Nigerian do business there
    - Create connections for collaboration
        - Kerr finds that patents are more likely to be cited by other inventors with surnames of similar ethnicities
    - Returnees can bring new abilities and new technologies
        - Since 1978, about 2.6 million Chinese have went abroad to study
            - About 1.1 million return
        - Many have founded companies or are senior managers
        - However, *Economist* article notes that returnees have had difficulties finding employment in China
            - One possibility is that Chinese society has changed since they left, so that they are unfamiliar with new industries such as e-commerce
            - Also note that more go abroad, so it isn't just the best and brightest who are returning anymore
                - The most talented may want to stay abroad because of better IP protection and less corruption
        - A study in Romania found migrants returning home earned 12-14% more than similar people who had not migrated
- The "Brain Drain"
    - Another important issue is whether educated people stay in the country or move out.
    - This effect hurts the lowest developing countries more
        - ¼- ½ of college educated from poor countries live in the OECD
        - Less than 5% of college educated from countries like India, China and Brazil live in the OECD.

        - In Ghana, ¾ of doctors leave within 10 years of qualifying
- Highest educated are more likely to leave
    - 2004 survey in India:
        - 40% of emigrants had more than high-school education
        - Compared to 3.3% of all Indians over age 25
- Two competing effects
    1. People leaving hurts the home country
    2. The prospect of leaving encourages others to get training ("brain gain")
        - Thus, the key is which effect dominates
- Are there advantages to having workers abroad?
    - Help provide entry into markets
    - Send money home to help families
        - Worldwide remittances $325 billion in 2010
        - In some low-income countries, remittances are more than 20% of GDP
        - In Guatemala, families receiving remittances from abroad spend more on education.
        - However, in Mexico they spend less, as they expect to leave for low-skilled jobs.
    - Encourages others to get more education
        - If stay at home, may be more likely to be unemployed, if there are fewer opportunities for education workers
- Competition: Quote from an Indian businessman who studied in the US and runs a chain of hospitals in India: "If you only live in India, you naturally measure yourself against Indian standards. If you have lived abroad, you measure yourself against the best in the world."
- Potential policies
- Tax expatriate workers
- Raise incomes of professionals at home
- Compensate hart-hit countries for their losses
- Time limited visas in the developed world
    - So that professionals get experience and then return home
- China offers subsidies to those that return ("1,000 Talents program")

III. Building Absorptive Capacity

- Absorptive capacity
    - Countries with weak domestic scientific capabilities more likely to passively adopt new technology
        - Import high tech products
        - If high-tech exports exist, they will be dominated by assembly operations of products developed elsewhere
    - Absorptive capacity also influences how far into a country new technology diffuses
        - E.g. does it stay in a few local clusters
    - Absorptive capacity depends upon
        - Business and macroeconomic climate
        - Stable economic environment important, so that investors aren't worried about losing capital due to conflict, rapid inflation, or widely varying exchange rates
        - Restrictions on firm exit prop up inefficient firms
        - Regulatory burdens greater in non-OECD countries
            - On average, 9.5 procedures taking 50 days to complete to start a new business
            - Compare to 6.2 procedures taking 16.6 days in OECD
        - Basic technological literacy & availability of advanced skills
            - Determine ability to implement, understand, and adjust to imported technologies
        - Policies to support innovative firms
- Education
    - Investment in science and technical education has been shown to be important.
        - However, demand is also important. Such investments are useless unless there are places for trained workers to go.
            - Thus, countries such as Korea and Taiwan offer tax incentives to those educated abroad who return home to teach or work.
        - Illiteracy has been falling
            - Biggest gains in lower-income countries, but there is still a gap (see Table 3.8)
    - Education can have spillover benefits
        - E.g. in agriculture, the highest educated are the earliest adopters of high-yield seed varieties.
            - This adoption leads to neighbors adopting more quickly, too.
        - Peer effects affect learning
            - People in developing countries may get too little education because they ignore this positive externality
        - In Rwanda, a shortage of plumbers and sheet metal workers constrained development of rain-harvesting technologies for drinking water

    - In poor countries, the poor receive disproportionately less education
        - Even if free, the opportunity cost of time may be high (e.g. time not spent in fields)
        - Quality of education may also be lower
- Creating local knowledge & supporting local R&D
    - Because of income constraints, developing countries face the decision to create or adopt new technologies.
        - It is often cost-effective to take advantage of work done elsewhere
        - Still, developing countries do some R&D
        - Basing local R&D on local knowledge can be a successful strategy
            - Much R&D is for agriculture
    - Public sector investment
        - Not only is the level of R&D low in developing countries, but the composition is different.
            - In LDCs, what little research that is done is publicly funded agricultural research. There is very little privately funded research.
    - Domestic R&D helps technology transfer
        - Studies find that firms with more in-house technical resources or more in-house R&D are more likely to use outside technologies
            - One country that does do much research (2.3% of GDP) is Korea
            - They did little (about 0.5% of GDP) until 1980s.
                - Firms found that acquiring technology from abroad was becoming increasingly difficult, so did more R&D to understand relevant technologies.
- Returns to R&D
    - Returns generally higher in developing countries
        - US/OECD: 20-40%
        - Middle income (e.g. Mexico, Chile): 60%
        - Low income (e.g. Nicaragua): 100%
    - However, returns to physical capital investment are also higher, so the gaps between them don't vary much
    - Given these high rates of return, why don't developing countries do more R&D?
        - Variables determining R&D levels include:
            - Depth of credit markets
                - Weak credit markets lead to higher borrowing costs
            - Quality of education & academic institutions
            - Extent of IPR
- Policy challenges for promoting local R&D
    - Adaptive R&D is not patentable, since not new to market
        - Reduces incentives for local firms to do R&D
    - Coordination failures
        - Some technologies rely on complimentary inputs (e.g. logistics, utilities) that may not be in place

        - These services have high fixed costs, so will not be provided until sufficient demand
            - But lack of services reduces demand, leading to a “vicious circle”
            - Thus, government can play an important role providing infrastructure
    - Threshold effects
        - Economies of scale make it difficult for new firms to enter global markets dominated by large-scale manufacturers
    - Knowledge spillovers
        - Often limited to local geographic regions
        - Thus, clustering and agglomeration effects important
    - While there are successful examples of governments promoting specific technologies (e.g. Brazil and biofuels), in general, governments promoting specific technologies often fail