

Lecture # 25 – Globalization and Technology Divide

Today's class was a discussion how globalization has changed technology, with a focus on the effect of globalization and technology on income inequality. Thanks to Yannek, Carli, and Cong for doing a great job setting up the issue, and to everyone for participating in a meaningful discussion. I've organized the notes below around the main themes of the readings, although they do not necessarily follow the order discussed in class.

I. Globalization of Knowledge

- Globalization of knowledge
 - Globalization has led to large increases in the share of enrolled college students who come from developing countries
 - For perspective, developing countries had about 80% of world's population in 1970. US had about 6%.
 - In 1970, US had 6% of population, but 29% of all college students. China and India had very few.
 - By 2010, over $\frac{3}{4}$ of college students came from developing countries
 - It isn't just students going abroad
 - International Association of Universities listed 82 institutions in Bangladesh in 2012, compared to about 12 in 1970s
 - Similar trends occurring for PhDs
 - Chinese PhDs in natural sciences and engineering exceeded those of US in 2007
 - EU graduated twice as many natural sciences and engineering PhDs as US.
 - As a result, more doctoral students in US programs are international students
 - US doctoral programs had about 1/3 international students in science and engineering in 2009
 - Roughly $\frac{1}{2}$ international students in engineering, computer science, and physics
 - However, quality is an issue
 - Most universities in national rankings are Western universities
 - 2006 McKinsey study of graduate students
 - Recruiters from Western firms viewed only 13% of university graduates from low wage countries as "suitable to work in a multinational company."
 - Assessment included English skills, cultural fit, and location near major international centers
 - As discussed earlier in the semester, R&D is also more globalized
 - Harder to compare
 - If wages are $\frac{1}{2}$ as high in a lower income country, the same expenditure on R&D pays for twice as much effort

- NSF uses purchasing power parity to compare across countries
 - Not only have R&D spending and publications increased, but also international collaborations
 - Papers with international co-author increased: 22% in 1990 to 35% in 2010
- Does the location of R&D matter?
 - Spillovers provide justification for government support
 - International knowledge spillovers suggest global, rather than national subsidies
 - There is some stickiness to spillovers, so that local areas benefit more
 - However, increased communication and globalization reduce this advantage
 - Increased international training of scientists reduces the need to use US taxpayer money to train S&E
 - Countries do not compete
 - A cure for cancer is valuable no matter where it comes from
 - Countries can use publicly funded R&D to boost strategic positions in some sectors
 - However, R&D is mobile, making it likely that MNCs and researchers will benefit from increased competition among jurisdictions

II. Globalization of Knowledge: Implications

- Implications of globalization of knowledge
 - Convergence of income across countries
 - As more countries have educated workers, comparative advantage of skilled workers in rich countries decreases
 - Thus, education need not continue to protect US workers from threats of globalization
 - In traditional “North-South” model of trade and development, advanced country monopoly from R&D-induced technological change gives workers an advantage.
 - Earn more because advanced technology makes these workers more productive than those in lower income countries
 - Because of public goods nature of knowledge, Freeman says it is the raw number of S&E workers, not the relative number, that matters.
 - If China has more S&E working on a given technology than France, they are more likely to come up with a technological advance

- Also allows firms to locate R&D closer to where production occurring
 - Increased inequality within countries
 - Within the US, trade increases unemployment, lowers labor force participation, and reduces wages
 - Spence and Hlatshwayo divided jobs into tradable and non-tradable sectors.
 - Between 1988-2008. value added per person increased in the tradable sector. However, number of jobs in this sector declined.
 - Jobs increased in the non-traded sector, but productivity declined.
 - Autor et al (2012) find that increased import pressure explains $\frac{1}{4}$ of decline in US manufacturing employment.
 - Elsbey et al. find that, of the 3.9 percentage point share in labor income in US over past 25 years, 3.3 percentage points attributable to trade.
 - Occurs because of factor price equalization, leading to reduction of relative wages for affected workers
 - Similar effects found elsewhere, so trade is not the only explanation
 - Labor share of national income fell from 66% in 1990s to 62% in the 2000s.
 - Typically, this share is thought of as constant.
 - A falling share suggests capital owners, rather than workers, are capturing the gains of productivity increases.
 - OECD estimates 80% of labor income share drop in OECD due to technology
- To evaluate the potential causes of the wage gap, we need to consider why wages differ?
 - They differ because various factors affect labor demand and labor supply curves.
 - Demand for labor
 - Recall that demand for factors is a derived demand: it depends on the firm's level of outputs and the cost of inputs.
 - That is, your demand for labor depends on what you expect to sell.
 - A firm will hire a factor as long as the revenue generated from the additional input is greater than or equal to the cost of hiring the input.
 - Marginal revenue product of labor (MRP_L) – the extra revenue that results from a hiring one more worker.
 - Therefore, the labor demand curve is just the downward sloping portion of the MRP curve.
 - Things that affect labor demand:
 - Skill of workers

- Demand is higher for high skilled workers.
 - Price of goods
 - Other factors available
 - More productive capital in the U.S. makes labor productive as well.
 - International competition
 - Firms demanding low-skilled workers can go to other countries, thus lowering their demand for domestic workers.
- Things that affect labor supply:
 - The cost of obtaining skills
 - To become a doctor or lawyer, you need years of training.
 - Wages should compensate people for this training.
 - Economists refer to accumulated skills as human capital.
 - Degree of pleasantness of the job
 - Population
 - People entering the workforce
 - For example, more immigration might increase the number of low-skilled workers
- Because of these factors, wages are higher for high-skilled workers
- Analysis
 - For supply side explanations to be the main cause, the supply of low-skilled workers would have to increase more quickly.
 - Even then, the actual wage of high-skilled workers would also fall. This is not consistent with historical data.
 - In reality, the supply of high-skilled workers has risen, due to increased college enrollments.
 - However, as recent evidence in the *NY Times* article suggests, the value of a college education remains high.
 - Thus, demand side explanations seem to be the main cause.
 - Technology vs. trade
 - Given that demand side considerations appear important, can we distinguish between trade and technology as an explanation?
 - The wage gap grew in the 1980s, but trade with developing countries didn't grow until the 1990s.
 - In fact, the wage gap has also grown in some of the developing countries that the US trades with.
 - This suggests that technology explains most of the gap.
 - Technology may make lower skilled workers obsolete
 - However, *NY Times* article suggests this is not enough to explain the gap
- Migration patterns
 - Many low-skilled workers migrate from Latin America to US, or from Eastern Europe and Africa to EU
 - High-skilled workers also migrate (e.g. "brain drain")

- Often a result of large differences in wages across countries
 - Brain drain harmful for smaller countries
 - For large countries, proportion of skilled workers lost is small
 - Migration rules vary by country
 - Some countries give visas based on skills
 - Australia gives advantages to applicants with Australian degrees
 - Labor standards
 - Globalization has led to improved conditions for workers
 - Consider backlash after fire in Bangladesh – globalization leads to awareness and pressure for changes to labor laws
 - In general, firms working in global marketplace more likely to comply with labor standards

III. The S&E Workforce: Is Internationalization a Concern?

- The US has historically been the world's scientific and technology leader.
 - US has 5% of world population, but...
 - employs nearly 1/3 of the world's S&E researchers
 - does 40% of world's R&D
 - publishes 35% of S&E articles
 - gets 44% of S&E citations
 - This is a comparative advantage for US in global marketplace. But, is it threatened by recent trends?
 - Freeman notes for propositions that threaten US economic leadership.
- Proposition 1: The US share of the world's S&E work force is declining rapidly.
 - In late 20th century, US share of S&E work force was high.
 - Many European scholars fled Nazis.
 - It took time for European higher education institutions to rebuild after WWII.
 - US funding was high during the cold war (E.g. Sputnik)
 - Now, the rest of the world is catching up. Table 5.1 shows ratios of S&E PhDs from foreign to US universities from 1975-2001
 - Asia: 0.22 in 1975 to 0.96 in 2001
 - Greatest growth has been in China, but ratio is still small (0.05 in 19889, 0.32 in 2001).
 - Projected to be 1.26 in 2010.
 - EU from 0.93 in 1975 to 1.54 in 2001
 - FR, DE, UK 0.64 in 1975 to 1.07 in 2001, so much is other nations

- o Within the US, more S&E PhDs go to foreign students

% of US PhD's granted to:	1966	2000
US born males:	71%	36%
US born females	6%	25%
Foreign born students	23%	39%

- o Foreign born students earned 58.7% of US PhDs in engineering in 2002.
- o Foreign born workers make up a larger share of the US S&E work force
 - Share of S&E PhDs working in US who are foreign born rose from 24% in 1990 to 37% in 2004.
 - Most of growth in PhDs came from foreign born S&Es
 - Many are students who come to the US and stay here.
 - Attracted by higher earning potential and better facilities than they would get in their home country.
- o Impact on wages
 - Increased supply of S&E workers lowers wages
 - Supply of US born S&E are more sensitive to lower wages than foreign born scientists, as there are more outside options.
- Proposition 2: Despite concerns over shortages, US job market for S&E specialties is too weak to attract more US students
 - o Freeman notes that if there is an equilibrium, there isn't a "shortage" in the economic sense.
 - o Rather, the concern is over the resulting equilibrium price – low supply of workers leads to higher wages, which hurts firms.
 - o What rewards matters to PhDs
 - Wages
 - From 1990-2000, wages for PhDs did not rise as fast as other specialties (doctors, lawyers, managers, college grads in general)
 - Moreover, during PhD training, students are paid low stipends
 - However, PhDs typically do not pay tuition, unlike doctors or lawyers.
 - Time to first full-time job (vs. post-doc)
 - In some sciences, graduates may take post-doc positions for three years before getting a full time job. These are also low paying positions.
 - Particularly a problem in the life sciences, where the ratio of post-docs to tenured positions is 0.77.
 - % of new PhDs obtaining faculty jobs within 3 years of degree:
 - 1973: 73% 1999: 37%
 - Probability of getting a grant
 - NIH grants are awarded to faculty members, not post-docs
 - Thus, young scientists are less likely to earn grants.

- Undergraduate market (BS in engineering)
 - This market is cyclical.
 - Tight labor markets that raise wages increase enrollments.
 - Leads to increased supply and lower wages 4-5 years later.
 - Similar patterns occur in other fields.
- Women and minorities
 - While fewer US men are going into S&E, more women and minorities are choosing this field. Why?
 - One possibility is that earlier discrimination artificially lowered numbers.
 - A second possibility is that women and minorities have fewer outside opportunities, and thus face a lower opportunity cost.
 - Seems less likely, at least for women, as medical and law school enrollments also up.
- Based on this, is there a “shortage”?
 - Freeman argues that the only reason wages aren’t higher is because the influx of foreign-born S&E keep supply steady.
 - Interrupting this flow would hurt US business, which is why they lobby for better immigration policy.
- Proposition 3: Increased foreign S&E, particularly in countries such as China and India, threaten the traditional US comparative advantage in high tech (vs. low skill manufacturing for developing countries).
 - North-South trade models posit that the North innovates and trades new goods to the South, while the South produces older goods.
 - Once the South has the technology to produce the newer good, it does, because of cheaper labor.
 - In such a model, a country benefits when a trading partner develops technology in an area where the countries do not compete, but is hurt if the partner country improves technology in an area where the two countries are competing.
 - If El Salvador improves banana production, it is good for Alaska, but bad for Nicaragua.
 - Freeman argues that increased S&E in the developing world could make this model obsolete. He calls this possibility human resource leapfrogging. Three factors are necessary for comparative advantage to shift from North to South:
 1. Southern country must have high population, so that it has large numbers of S&E workers even though a low percentage of the population is in this field.
 2. Institutions are important to link business and university, giving the US an advantage. Eventually, larger numbers of workers may close the gap.
 3. The South also needs production competence, which is more likely in a large country with a large labor pool.

- Note that in India and China, appropriate infrastructure is developed in specific areas, rather than throughout the country.
 - The key assumption in Freeman's model is that technological superiority is endogenous, and that large numbers of S&E workers can change it.
 - How would losing this comparative advantage harm advanced economies?
 - Would need to shift resources to less desirable sectors with lower productivity growth.
 - Wages would remain high, due to skilled workforce.
 - However, monopoly rents would be transferred from North to South.
 - Note that in Freeman's model, US workers are hurt more if foreign-born S&E work in their home country, rather than the US. There, they build up the technological capabilities of a competing nation.
 - Indicators that the threat is real:
 - High tech firms are locating R&D facilities in India and China.
 - Offshoring of skilled work.
 - China is closing technology gap.
 - China's share of high tech output is growing.
- Proposition 4: Diminished comparative advantage will create adjustment problems for US workers.
 - While the spread of technology is good for the world, it may not be good for all US workers.
 - Loss of monopoly rents will make it harder for US firms to raise wages and benefits.
 - Freeman argues in long-term, the US will benefit.
 - However, the transition may be difficult.
 - Policy options
 - Encouraging foreign born S&E graduates to stay in the US would slow the growth of competition in other countries.
 - Increasing government R&D support to increase domestic supply.
 - Social insurance policies.
 - Preserving links between business and university
 - Freeman argues this is a comparative advantage for the US.