Chapter 2: Trade, foreign direct investment, and innovation: the emergence of developing countries in the global economy

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Introduction

Using the United Nations (UN) classification of countries into three mutually exclusive categories – least developed, developing, and developed – this paper discusses recent trends in the allocation of global economic output across these groups of countries as well as their involvement in the international economy as measured by exports and foreign direct investment (FDI) during 1990-2014.[1]

The early part of our chosen time period of study roughly coincides with the conclusion of the last major round of multilateral trade negotiations – i.e. the Uruguay Round – that led to the formation of the World Trade Organization (WTO) and the ratification of the Trade Related Agreement on Intellectual Property Rights (IPRs) in 1995. As is well known, TRIPS made it mandatory for all WTO members to meet certain minimum standards of IPR protection. As a result, developing countries were forced to alter their IPR policies to align them closer to those of rich countries.[2] Accordingly, we also consider the evolution of research and development (R&D), technology transfer, and innovation (as measured by patenting) in various groups of countries during the post-TRIPS era.[3]

To set the stage, we begin by briefly considering the evolution of global economic output as measured by the share of global gross domestic product (GDP) produced by various groups of countries during 1990-2014.

In 1990, developing countries accounted for only 20.5% of global GDP, but by 2014 their share of global GDP had almost doubled (to just under 40%). Developed countries on the other hand, experienced a significant and steady decline in their share of global GDP from 78.8% in 1990 to 58.9% in 2014. While the share of global GDP residing in least developed countries (LDCs)

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remains small (about 1.2% in 2014), this share increased by roughly 70% during 1990-2014. Thus, our first major point is simply that the economic clout of developing countries as a whole has increased rather sharply during the last 25 years or so.

It is worth examining the geographic variation in the economic fortunes of various regions within the developing world. This information is presented in Table 1.

Table 1: Geographic variation in GDP within developing countries (excluding LDCs)

Region	1990	1995	2000	2005	2010	2014
Africa	9.2%	7.3%	7.2%	7.5%	6.7%	6.1%
America	24.7%	29.3%	29.8%	23.3%	22.6%	19.6%
Asia	47.7%	55.3%	58.2%	60.8%	62.4%	66.8%
Developing total (tn $)	4.7	6.5	7.4	11.9	23.0	30.9

Source: UNCTAD

The major lesson of Table 1 is that almost all of the observed increase in economic activity within the developing world was concentrated in Asia. In 1990, Asian developing countries accounted for 47.7% of the GDP produced by all developing countries. The share of Asian developing countries rose steadily during 1990-2014, eventually reach 66.8% in 2014. By contrast, African developing countries experienced a rather modest increase in their share of global GDP (from 1.9% to only 2.4%).

Since living standards of individual citizens are more accurately measured by per capita income, as opposed to the overall size of a country's economy, it is useful to consider how per capita income of various groups of countries has evolved during 1990-2014. Despite some fluctuations, GDP per capita exhibited an overall upward trend for all country groups over the past three decades. Second, the growth rate of GDP varied substantially across country groups. In particular, while the average annual growth rate of developing countries was 6.8% that of developed countries was only 3.3%. These trends capture a decline in the income gap between the developed and the developing world: though GDP per capita of developing countries in 1990 was only 6.1% of that for developed countries, this ratio had more than doubled to 13.3% by 2014. The annual growth rate of GDP per capita of LDCs was 4.8%, which was moderately higher than that of developed countries.

Thus, when viewed with the lens of per capita GDP, the richest and the poorest countries experienced smaller growth in income relative to the rest of the world. These growth paths imply that although the relative income gap between developed countries and the rest of the world has been shrinking, the gap between developing countries and LDCs has been *widening*. Overall, as developed and developing countries together account for a dominant share of world GDP, the observed growth pattern suggests that between-country income inequality has been declining in the global economy.

The main message conveyed by the above facts is that developing countries as a group have grown significantly more important in the world economy, both from the perspective of the size of their economies and the per capita income of their citizens. However, not all regions in the world have shared equally – developing countries in Asia have gained a lot more ground with respect to the developed world relative to their counterparts in other parts of the world.

With this broad overview of the allocation of global GDP in hand, we now turn to the involvement of developing countries in the global economy as measured by exports and FDI.

Trade and foreign direct investment

Table 2 reports the shares of various country groups in global merchandise exports during 1990-2014.

Table 2: Share of global merchandise exports

Country	1990-94	1995-99	2000-04	2005-09	2010-14
LDCs	0.5%	0.5%	0.6%	0.9%	1.1%
Developing countries	27.7%	30.3%	34.4%	41.2%	47.0%
Developed countries	71.8%	69.2%	65.0%	57.9%	51.9%
Global exports (tn $)	18.9	27.4	36.0	65.4	90.1

Source: UNCTAD

As Table 2 shows, developing countries saw their share of world exports increase substantially from 27.7% during 1990-94 to 47.0% during 2010-14. At the same time, the share of developed countries in global exports declined sharply from 71.8% to 51.9%.[4] It is worth clarifying that these changes reflect only a relative decline in the exporting prowess of developed countries: in absolute terms, exports of all country groups increased, with the growth rate being

the highest in developing countries. If one takes a closer look at the set of developing countries one discovers that Asian developing countries have accounted for a large chunk of the total merchandise exports of developing countries as a whole: their share of merchandise exports of all developing countries increased from 69.2% during 1990-94 to 74.3% during 2010-14.

The overall patterns for services exports look fairly similar to goods exports, albeit the changes in shares are of relatively smaller magnitude. The developing countries' share of global exports of services rose from 20.9% over 1990-94 to 31.3% over 2010-13, representing an increase of roughly 60%, which is smaller than the corresponding percentage increase for merchandise exports. As one might expect, as a group developing countries constitute a smaller share of global exports of services than they do of global merchandise exports (31.3% compared to 47%).[5]

We now turn to the experience of various country groups with respect to FDI. It is generally recognized that in today's global economy, trade between subsidiaries and headquarters of multinational firms, may account for one-third of total world trade. It is also well known that sales of subsidiaries of multinational firms exceed worldwide exports of goods and services. Indeed, FDI is the dominant channel through which firms serve their customers in foreign markets. Table 3 shows the evolution of inward FDI flows to various country groups during 1990-2014.

Table 3: Inward FDI flows as a share of global flows

Country group	1990-94	1995-99	2000-04	2005-09	2010-14
LDCs	0.6%	0.7%	1.0%	1.0%	1.6%
Developing countries	30.7%	28.7%	28.6%	38.0%	50.1%
Developed countries	68.7%	70.6%	70.4%	61.0%	48.3%
Global FDI (tn $)	1.0	3.0	3.9	6.9	7.0

Source: UNCTAD

During 1990-94, developing countries attracted roughly 30.7% of global FDI inflows and their share rose to 50.1% over 2010-14 – i.e. in recent years, developing countries have tended to attract *more* FDI than developed ones. Indeed, the share of global FDI flowing into developed countries fell sharply from 68.7% during 1990-94 to 48.3% over 2010-14. Finally, the share of LDCs almost tripled over the time period under examination despite remaining fairly low relative to other country groups – LDCs received only 1.6% of global FDI inflows over 2010-14.

Table 4 shows the geographic shares of inward FDI flows within developing countries. Unlike the case of GDP and contrary to what one might expect, Asian developing countries experienced a moderate *decline* in inward FDI relative to other regions, although their share remained dominant throughout the time period under study. An important point to note from Table 4 is that African developing countries have tended to receive a fairly small share of the total FDI inflows into developing countries – the share of African developing countries never exceeded 6.2% during the examined time period.

Table 4: Geographic variation in inward FDI flows within developing countries

Region	1990-94	1995-99	2000-04	2005-09	2010-14
Africa	5.9%	3.5%	4.0%	6.2%	4.3%
America	26.1%	37.8%	32.8%	25.2%	31.2%
Asia	66.3%	55.6%	58.3%	57.6%	55.9%
Developing total (tn $)	0.3	0.9	1.2	2.8	3.9

Source: UNCTAD

The observed changes in the pattern of inward FDI flows have direct implications for the global distribution of FDI stocks.[6] Table 5 shows that the global stock of FDI increased from roughly $2.2 trillion in 1990 to over $24.6 trillion in 2014.[7] Moreover, developed countries saw their collective share of global FDI stock decline from 76.7% in 1990 to 63.3% in 2014, whereas developing countries' saw their share increase from 22.8% to 35.8%. These changes in FDI stocks are smaller in magnitude compared to changes in FDI flows since, historically, developing countries have tended to attract less FDI than developed ones.

Table 5: Inward FDI stocks as a shares of the global stock

Country group	1990	1995	2000	2005	2010	2014
LDCs	0.5%	0.5%	0.5%	0.7%	0.7%	0.9%
Developing countries	22.8%	23.5%	23.5%	25.7%	34.1%	35.8%
Developed countries	76.7%	76.0%	76.0%	73.6%	65.2%	63.3%
Global FDI (tn $)	2.2	3.6	7.2	11.0	19.6	24.6

Source: UNCTAD

Traditionally one thinks of capital flowing from where it is abundant (i.e. developed countries) to where it is scarce (i.e. developing countries). However, somewhat surprisingly, the increase in economic capabilities of many developing countries has also seen them become

important source countries for FDI. During 1990-94, only 11.0% of global FDI came from developing countries whereas during 2010-14 this share rose had risen to an impressive 32.3%. Concurrently, this upward trajectory in outward FDI flows from developing countries was accompanied by a reduction in the share of global FDI originating from developed ones, which fell from 88.9% to 67.4% over the examined period. Finally, as might be expected, LDCs continue to account for a fairly tiny portion of global outward FDI, with their share being a mere 0.3% during 2010-14.

Table 6: Geographic variation in outward FDI flows within developing countries

Country	1990-94	1995-99	2000-04	2005-09	2010-14
Africa	4.5%	3.9%	0.3%	2.0%	1.4%
America	14.5%	22.1%	30.4%	23.1%	21.1%
Asia	78.7%	71.4%	61.6%	61.4%	64.9%
Developing FDI (tn $)	0.1	0.3	0.5	1.5	2.6

Source: UNCTAD

Table 6 reports the variation in the shares of outward FDI flows within the group of developing countries. Asian countries accounted for a dominant share of these flows – indeed, their share exceeded 60% over the entire time period. Nevertheless, it is perhaps surprising that the share of FDI outflows generated by Asian developing countries declined from 78.7% during 1990-94 to 64.9% during 2010-14, while that of American developing countries rose from 14.5% to 21.1%. Thus, although both Asian and American developing countries are generating increasingly greater outflows, the growth rate of outward FDI has been larger for the latter group. The share of outward FDI stocks from developing countries rose substantially from only 6.2% in 1990 to 21.5% in 2014. Over the same period, developed countries' share of outward global FDI fell from 93.8% to 78.4%.

Generally, when undertaking FDI, an investor's primary purpose is to gain an effective voice in the management of the enterprise receiving the investment. Thus, the key distinguishing feature of FDI from the perspective of host countries is that it transfers control of local enterprises to foreign hands. Sometimes FDI results in the establishment of wholly-owned subsidiaries of multinational firms whereas at other times it involves shared ownership between local and foreign firms in the form of international joint ventures. While FDI between industrialized countries

primarily occurs via international mergers and acquisitions, FDI into developing countries is more likely to involve the construction of new production facilities, something that is often referred to as greenfield FDI. However, both types of FDI carry the potential for international knowledge transfer: while mergers and acquisitions are more likely to yield productivity improvements via changes in management and organization structure of acquired firms, greenfield FDI leads to direct transfer of production know-how either in the form of entirely new products or via improvements in existing production processes. Thus, FDI is important not just because it brings in much needed capital to many developing countries but also because it can serve as a major channel of international technology transfer.[8]

The scale of the technology activities of major multinational firms can be difficult to grasp: for example, in 2009 the R&D expenditures of Toyota exceeded that of India, a country of roughly 1.2 billion people (UNCTAD, 2010). Similarly, in a typical year, over twenty multinational firms invested more in R&D than Turkey, a country of roughly 75 million people. These facts are a sharp reminder of the uneven nature of the technology terrain of today's world. But this uneven environment is precisely what creates the potential for securing large productivity gains by encouraging international technology transfer to developing countries.

Royalties and licensing fee receipts pertaining to international exchange of technologies between firms provide one way of measuring global flows of technology.[9] As per this metric, much of the global action in technology transfer occurs within developed countries and lies within the boundaries of multinational firms: estimates vary but in a typical year over 80 percent of global royalty payments for international transfers of technology are made between subsidiaries and their parent firms. At a global level, the royalties and licensing fee receipts accruing to multinational firms increased from $29 billion in 1990 to $311 billion in 2014.

Of course, access to foreign technologies via FDI is only one channel via which developing countries can boost their technological capabilities. Furthermore, we ultimately care about technological improvements only to the extent they help raise people's standard of living. The central determinant of a country's long-run standard of living is its productivity or what economists usually call total factor productivity – i.e. that part of total output that is not explained by the level of inputs used in production. To raise productivity, a country needs to learn to make more efficient use of its resources. From a global perspective, technological change which helps achieve this

objective is often the result of deliberate investments in R&D. Accordingly, we now consider the global evolution of R&D and innovation (as measured by patenting activity).

Global trends in R&D and innovation

While most of the global R&D continues to be concentrated in the developed world, developing countries have started to increasingly invest in R&D. But one might wonder if such investments on their part are really necessary. Couldn't developing countries simply rely on the fruits of foreign R&D without making any such investments of their own? Following classical trade theory, shouldn't developing countries simply purchase technology from other countries that have comparative advantage in R&D or rely on FDI and other channels of international technology transfer? After all, as noted above, R&D is hardly an end in itself and the ultimate objective is to raise productivity.

There are at least two responses to this viewpoint. First, the prescription of efficient specialization based on comparative advantage applies only under a limited set of assumptions, many of which are not supported by empirical evidence. New technologies are rarely produced under conditions of perfect competition and the market for technology is plagued by transactions costs that stem (partly) from the presence of asymmetric information between buyers and sellers. Involvement in R&D by potential buyers can facilitate the market based exchange of new technologies by lowering transactions costs.

A second reason for conducting domestic R&D is that technological change is a dynamic phenomenon and technology acquisition is an on-going process. The cumulative nature of technological change creates an intertemporal link between current investments in R&D and future technology acquisition. Not investing in local R&D can force a country to continually bear high transactions costs for technology acquisition.

Private agents invest in R&D in order to profit from it. If first mover advantages created by R&D are small and others can easily imitate a new process or product, the incentive to invest will generally be weak. This is presumably why we have intellectual property rights: such rights grant inventors temporary monopoly power (typically 20 years for patents) by forbidding others from imitating and copying their inventions. To the extent that protection of IPRs has been

strengthened in developing countries by the ratification of TRIPS in 1995, incentives for R&D should have been encouraged world-wide.[10]

But protection of IPRs is hardly sufficient for ensuring socially efficient levels of R&D since investors may fail to capture the full social benefits generated by their inventions. At the most basic level, an inventor is generally unable to extract the full benefits consumers enjoy from its invention because third degree price discrimination (under which each consumer pays the maximum it is willing to pay for the new product) is rarely feasible.

A second fundamental reason that the market may yield too little investment in R&D is because of positive externalities created by R&D. Due to the cumulative nature of technological change, it will generally be impossible for any inventor to fully extract the present discounted value of social surplus created by its investment. Consider, for example, the social value of the invention of electricity and the role it has played in generating future inventions. It is simply impossible for the market mechanism to fully anticipate the social value of such an invention at the time that it occurs. Sir Isaac Newton famously remarked that if he had seen further than others, it was because he had stood on the "shoulders of giants". This Newtonian insight succinctly captures the cumulative nature of knowledge and it is especially relevant for developing countries, many of whom are relative new-comers to the fields of global innovation and R&D.

It is clear then that the market is unlikely to yield the socially optimal level of R&D.[11] If one further accepts the argument that the market errs, on average, on the side of too little investment in R&D as opposed to too much then an argument for encouraging R&D beyond the level provided by the market naturally emerges. However, one still needs to be careful: what type of R&D should be encouraged? It is useful to remember that R&D comprises of "research" and "development" and that positive knowledge spillovers are more likely to arise in research than in development. For example, it is common for the pharmaceutical companies to point out how expensive it is for them develop a new pharmaceutical product and their critics, often rightly, point out that a significant share of the R&D cost of a typical new pharmaceutical are actually development and marketing costs that have little to do with research and also unlikely to yield significant positive externalities. Thus, any policy initiative aimed at increasing R&D stands to be more beneficial if it encourages investments in "research" as opposed to "development" since the case for knowledge spillovers and externalities seems to be weaker for the latter.

One can gauge the level of innovative activity in the global economy from two perspectives: the input side as captured by investment in R&D and the output side as measured by patent applications and grants.[12] We begin with the input side by considering the variation in the ratio of national R&D expenditures to GDP (often called a nation's R&D intensity) across various country groups. Since R&D intensity is a scale-free measure, it is useful for cross-country comparisons.

Figure 1 shows R&D intensities during 2001-11 for high-income and upper middle-income country groups together with five major developing countries that are commonly known as the BRICS (i.e. Brazil, Russia, China, India, and South Africa). First, as one might expect, the R&D intensities of high-income countries was substantially greater than those of middle-income countries: while the average R&D intensity of high-income countries was around 2.3% over the period under study, that of upper middle-income countries hovered around 1%.

While the gap in R&D intensity between developed and developing countries has been shrinking over time, not all countries have stepped up their R&D intensities equally. China has exhibited the greatest growth rate in R&D intensity among all developing countries. Within the BRICs, a moderate increase in R&D intensity occurred in Brazil and India whereas the R&D intensities of countries such as Russia and South Africa were fairly stagnant over the time period under study.[13] All in all, there has been little increase in R&D in most developing countries (especially LDCs). Economic analysis suggests that the expected returns from R&D ought to be higher for countries that are further behind the world technology frontier. Why is it then that most developing countries, especially the LDCs, invest so little in R&D? Goñi and Maloney (2014) offer a potential explanation for this puzzle. They show that the returns that a country enjoys from R&D actually exhibit an inverted U-shape curve – i.e. they initially increase and then decrease with its distance from the global technology frontier. The key insight is that the efficacy of R&D also depends upon several complementary factors such as the quality of a country's scientific infrastructure, the overall functioning of its national innovation system, and the quality of the local private sector. These factors tend to become weaker as a country's distance from the technology frontier increases and can undermine the returns from R&D implied by the existence of a large technological gap.

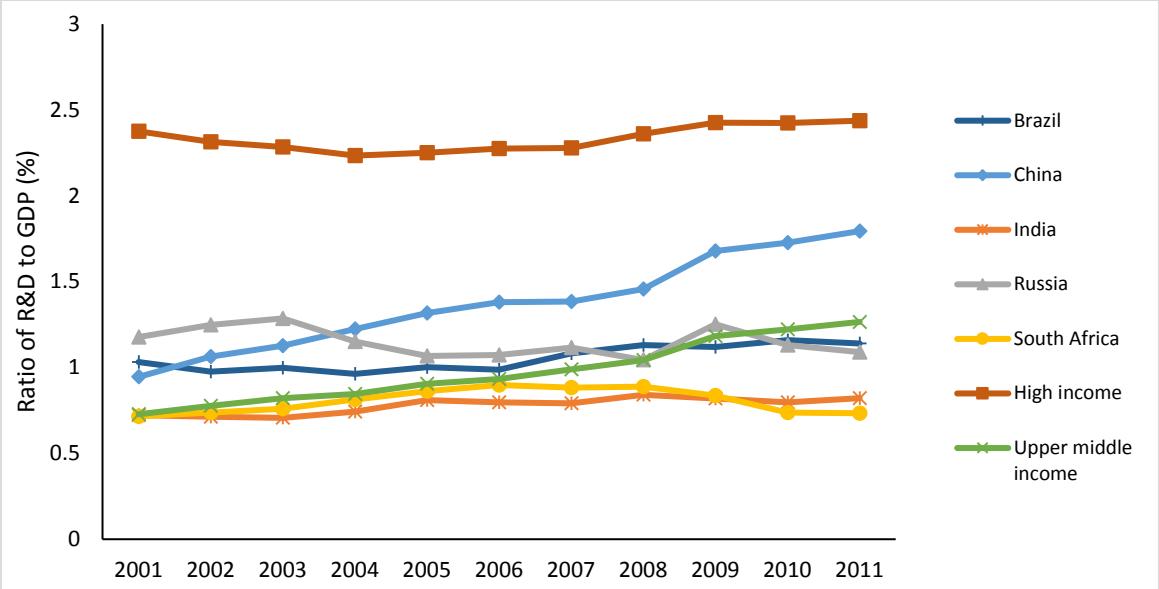

Figure 1: National R&D intensities
Source: World Development Indicators, 2015

Consider now the output side of innovation as measured by data on patent applications and grants throughout the world. Geng and Saggi (2015) note that global patent applications have grown rapidly during the post TRIPS era. Indeed, global patent applications in 2014 were almost thrice as many as those in 1990. Asia was the single biggest driver of this surge in global patent applications: Asia's share of global patent applications hovered around 50% during 1991-2011 and rose to nearly 60% in 2014. Within Asia, the big story, of course, has been the emergence of China (something that also shows up in our analysis of R&D investment). So sharp and salient has been China's rise that patent filings in China during 2014 not only exceeded those in Japan but also the United States, making China the country with the largest number of patents filed in 2014. Roughly 35% of all patent applications filed in the world during 2014 were filed in China.

During 2014**,** nearly 1.2 million patents were granted world-wide with roughly 40% of them accruing to non-residents, a clear reflection of the globalization of contemporary innovation. Roughly 10 million patents were in force globally during 2014**,** about 25% of these being in the United States. From 1990 to 2014, the number of patents granted in Asia increased by more than 700%**.** While more patents were granted in 2014 in all Asian countries, the sharpest

increase was witnessed in China where the number of patents granted in 2014 was almost 57 times that in 1991.

One might wonder whether patenting activity within China has been driven primarily by local or foreign innovation. Two facts help shed light on this issue. First, the ratio of resident to non-resident patent applications increased from 57.5% in 1990 to 86.3% in 2014.[14] Second, the share of patents granted to residents in China shot up from 31.8% in 1990 to almost 70% in 2014. Thus, it seems that indigenous innovation in China has certainly played an important role in driving local patenting activity.

How successful have developing countries been in globalizing their local innovations? This question can be partially addressed by considering the rate at which patents have been granted to developing countries by the rest of the world. In this regard, is useful to consider how developing countries have fared relative to rest of the world in terms of patent filed for and granted by the United States Patent Office (USPTO). Table 7 reports the total number of patent applications filed by foreign nationals during 1990-2014 at the USPTO as well as the shares of developing and developed countries in these application filings.

Table 7: Patent applications as shares of foreign total at the USPTO

Country	1990-94	1995-99	2000-04	2005-09	2010-14
Developing countries	7.0%	12.5%	17.1%	22.4%	28.0%
Developed countries	93.0%	87.5%	82.9%	71.4%	72.0%
Foreign total	388,328	499,467	751,235	1,127,498	1,355,601

Source: USPTO

Two facts jump out from Table 7. First, the total number of patents applications filed by foreigners at the USPTO increased rather sharply (i.e. by almost 250%) during the last twenty five years or so, an indication of the increasing importance of the US economy to foreign innovators. Second, patent applications from developing countries literally surged: during 1990-94, developing countries accounted for only 7% of all the patent applications filed by foreigners at the USPTO whereas by 2010-14 their share had increased to a remarkable 28%. This surge in patent applications by developing countries at the USPTO dovetails nicely with their increased prominence in world exports.

We should note here that the UNCTAD classification of countries into various economic categories labels three fairly rich and technologically advanced countries as developing countries: Singapore, South Korea, and Taiwan. If these three countries were to be counted among the set of developed countries, then the share of patent applications filed by developing countries at the USPTO would be much smaller (8.6% during 2010-14). Even so, this share is a big improvement relative to the period 1990-94 during which developing countries accounted for only 1.5% of the patents filed by foreign firms at the USPTO.

Table 8 shows how the total number of patents granted by the USPTO to foreign nationals and the respective shares of developing and developed countries have evolved over time. As can be seen from this table, the share of patents granted to developing countries increased from roughly 5% to 25%.[15] This is strong evidence of an increase in the innovative capability of developing countries.

Table 8: Patent grants as shares of foreign total at the USPTO

Country	1990-94	1995-99	2000-04	2005-09	2010-14
Developing countries	4.9%	9.9%	13.9%	19.5%	24.9%
Developed countries	95.1%	90.1%	86.2%	80.5%	75.1%
Foreign total	224,220	281,304	392,371	396,111	660,133

Source: USPTO

It is worth taking a closer look at some of the major developing countries to see which of them have been driving the surge in foreign patenting activity at the USPTO. Table 9 presents the relevant data.

Table 9: Patent grants as shares of developing countries at the USPTO

Country	1990-94	1995-99	2000-04	2005-09	2010-14
Brazil	2.4%	1.3%	1.0%	0.6%	0.7%
China	2.1%	1.2%	2.4%	6.1%	14.4%
India	1.2%	1.1%	2.3%	3.5%	5.8%
Russia	0.4%	2.5%	1.8%	1.1%	1.1%
South Africa	4.7%	2.0%	1.0%	0.6%	0.4%
Developing total	10,918	27,857	54,326	77,064	164,174

Source: USPTO

Table 9 shows that China and India were responsible for almost all of the increased in foreign patenting by developing countries at the USPTO. Indeed, these two countries accounted for almost 20% of all the patents granted to nationals of developing countries by the USPTO during 2010-14, with China's share being almost thrice that of India's.[16]

The above results need to be interpreted with some caution because patent applications are often filed by groups of researchers and the country of origin of an application is identified by the applicant that is listed first. Since an increasing number of inventions and patent applications reflect the collective efforts of groups of researchers originating from multiple countries, the data reported in Tables 7-9 may partly reflect enhanced collaboration between innovators from developing and developed countries rather than the technological progress of developing countries alone.

In recent years there has also been substantial growth in the investments made by international firms in setting up research facilities in foreign countries. These research affiliates and R&D facilities have several purposes: modifying products for local markets, situating R&D close to growing markets, using lower-cost research personnel, and establishing centers of original innovation. While most such new facilities have been set up in developed economies, large developing countries have started to become major host countries in recent years. For example, Japanese multinationals allocated 38% of their R&D activities abroad to developing countries, a significant increase from 6% in 1993. Large developing countries such as China and India have been among the top ten recipients of R&D facilities involving multinational firms in recent years.

Branstetter et al. (2015) examine data on patents issued by the US to foreign residents and find that a majority of patents in China (as well as India) have been granted to researchers working for subsidiaries of multinational corporations. They argue that the general rise of international co-invention reflects an expanded international division of labor within global R&D networks, much like the slicing of the global production chain across the world. The authors also compare the quality of patents (as measured by citations) granted to Chinese or Indian indigenous inventions with those granted to (a) co-inventions with inputs from advanced economies and to (b) co-inventions with inputs from advanced economies under the sponsorship of multinational firms.

They find that co-invented patents tend to be of higher quality, as do patents developed under the sponsorship of multinationals.

Table 10 presents the shares of R&D expenditure by foreign affiliates of US parent companies in various developing countries. It can be observed that US companies have been spending an increasing share of R&D expenditure in developing countries. In particular, this share rose substantially from 7.4% in 1997 to 19.6% in 2013. Nevertheless, within developing countries the pattern varies considerably. The exceptional performers have undoubtedly been China and India: back in 1997 both countries together accounted for only 5.4% of the R&D expenditure in developing countries, but their total share surged to 49.5% in 2013. Such a strong expansion of US foreign affiliate R&D did not occur in other major developing countries such as Brazil, Russia and South Africa.

Table 10: Shares of R&D expenditure by foreign affiliates of US parent companies

Country	1997	2000	2005	2010	2013
Brazil	3.0%	1.2%	1.5%	3.5%	2.5%
China	0.2%	2.5%	2.4%	3.8%	4.5%
India	0.2%	N/A	1.2%	4.3%	5.2%
Russia	N/A	0.0%	0.1%	0.2%	0.3%
South Africa	0.2%	0.1%	0.1%	0.2%	0.2%
Developing countries	7.4%	11.2%	10.9%	19.8%	19.6%
Developed countries	90.8%	86.0%	87.1%	77.6%	77.2%

Source: U.S. Bureau of Economic Analysis

Concluding remarks

The economic trends discussed in this paper show that, during the past 25 years or so, developing countries as a group have gained much greater prominence in the global economy. Whether one considers trade, FDI, or innovation, developing countries now possess substantial economic clout in the world. However, our analysis also shows that much of these gains have been concentrated in major Asian countries (especially China), By contrast, the least developed countries (LDCs) of the world have not seen their fortunes improve much. On the innovation side, the sharp increases in patenting activity and R&D investments documented in this paper are impressive but the real challenge facing developing countries (such as China) that are investing heavily in R&D is to raise the quality of their innovations. Raising the level of R&D investment in of itself is insufficient and

perhaps a more appropriate policy goal for large developing countries should be to increase the productivity of their R&D.

What can be done to help LDCs better integrate into the global economy? Since the global multilateral trading system includes many clauses designed to grant LDCs greater flexibility, we do not think that the economic performance of such countries can be significantly improved by further altering the system to grant them more flexibility. Rather, it seems that the constraints facing such countries are primarily domestic so that meaningful economic reforms would need to be indigenous and built from the ground up. While policy recommendations in this regard are beyond the scope of the present paper, we do highlight a few key points below.

To better integrate themselves with the global economy, LDCs need to improve their ability to absorb foreign technologies which in turn is critically dependent on the level of local human capital stock. LDC governments must play their part in strengthening the local education systems at all levels (from the primary to post-secondary). Fruitful policy intervention by LDCs must also recognize that market agents, especially multinational firms, play a crucial role in the process of trade, FDI and innovation. In addition to major investments in improving local education systems, investments in local infrastructure, construction of transparent and competitive tax regimes, and improvements in public governance are clearly important to global firms when they are choosing locations for their production and R&D facilities. In this sense, such investments are important complements to investments in human capital, training, and research capacities in universities and research laboratories, which are critical for linkages to global innovation networks. Similarly, fiscal incentives to domestic enterprises for undertaking meaningful R&D programs can help make such firms more attractive affiliates or partners in international technology contracts.

The smaller size of LDCs does limit the range of policies that they can effectively employ to encourage FDI and technology transfer. For example, the technology transfer requirements on FDI that have been imposed by China (and to a lesser degree by some other countries in the past) are unlikely to succeed in LDCs. Such policies are premised on the fact that multinationals are keen to enter the Chinese market and would therefore be willing to share technological know-how with local Chinese firms. For smaller developing countries, any attempt at implementing Chinese type technology transfer policies would likely be counter-productive since multinationals may

prefer to opt out of their markets as opposed to enter under forced technology transfer. If this happens, a small country can find itself shut out of the global production and innovation chains that drive economic activity in today's world economy.

Endnotes

[1] As per the United Nations Conference on Trade and Development (UNCTAD), FDI refers to an investment made by an investor in a foreign country to "acquire lasting interest in a local enterprise". UNCTAD is a permanent international organization established by the UN general assembly in 1964 and, in what follows, we utilize its data on global FDI flows and stocks.

[2] While TRIPS took effect on 1 January 1995, developing countries were given five years (until 2000) to make their laws and practices TRIPS compliant. Least-developed countries were given an even longer timer window: they had 11 years to achieve TRIPS compliance, until 2006 -- which was then extended to 2013 in general, and to 2016 for pharmaceutical patents and trade secrets.

[3] Our analysis is almost entirely descriptive in nature and it does not imply that the observed changes in R&D and innovative activity were caused by TRIPS.

[4] The most striking performer among developing countries was China whose share of global merchandise exports jumped from 1.6% to 11.2%, representing an increase of 600%. The shares of other developing countries either rose moderately or even declined over time. Thus, to a large extent, China has been the major driving force behind the increased presence of developing countries in the global economy.

[5] It is important to briefly note that the fragmentation of production via global value chains (GVCs) that span multiple countries is a major feature of today's global economy. While some large developing countries such as China are playing an increasingly important role in GVCs, not all developing countries are well-integrated into them. The uneven participation of developing countries in GVCs is an important issue with potentially far-reaching implications for their growth and welfare. However, an in-depth treatment of this issue is outside the scope of our current analysis.

[6] UNCTAD estimates FDI stocks by either cumulating FDI flows over a period of time or adding flows to an FDI stock that has been obtained for a particular year from national official sources or the International Monetary Fund's FDI data.

[7] See Kalotay (2017) for a comprehensive discussion of the changing landscape of FDI flows and stocks in the global economy over 1991-2005.

[8] See Saggi (2002 and 2016) for extensive surveys of the economics literature exploring the inter-linkages between trade, FDI, and international technology transfer.

[9] Of course, royalty payments only record the explicit sale of technology and do not capture the technology transfer via imitation, trade in goods, and other channels.

[10] While the level of IPR protection in individual developing countries may not affect global incentives for R&D, the level of such protection in all developing countries (as a group) is likely to have a significant effect on global R&D. See Saggi (2016) for further discussion of this issue.

[11] There also exist some good arguments as to why the market may lead to overinvestment in R&D from a social welfare perspective. For example, the market can yield overinvestment in R&D due to *strategic competition* between investors since each investor ignores the negative effect of its own investment on that of

other investors. In any case, it is virtually impossible to determine the socially optimal level of R&D for any given industry, let alone the global economy.

[12] Of course, such patent statistics do not take into account the fact that not all innovations are equally valuable.

[13] A focus on R&D intensities runs the risk of masking the significant variation that characterizes the *level* of R&D investments of various developing countries. It is worth noting that in terms of absolute levels of R&D investment, China has no peers in the developing world: it invested roughly $1.3 trillion in R&D in 2011 whereas Brazil invested $29 billion, India about $15 billion, and South Africa only about $3 billion.

[14] One interesting question that we are unable to address here due to data limitations is the following: what role have multinational firms played in the surge in patenting activity in China? Hu and Jefferson (2009) estimate that over 1996-2001, roughly 20% of the increase in patent applications can be attributed to FDI. Their analysis accounts for patents applications directly filed by multinationals as well as the indirect spillover effects of FDI on the patenting behavior of Chinese firms.

[15] If Singapore, South Korea, and Taiwan are classified as developed countries then the developing countries' share of the total patents granted to foreigners by the USPTO increases from 1.2% to 6.4%.

[16] China and India's joint share of total patents granted to developing countries by the USPTO during 2010-14 exceeds 78% if Singapore, South Korea, and Taiwan are classified as developed countries.

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