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ORIGINAL PAPER

Technology diffusion, international integration and participation in developing economies - a review of major concepts and findings

T. Gries[1] **· R. Grundmann**[1] **· I. Palnau**[1] **· M. Redlin**[1]

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Abstract Technical change is a major driving force for economic growth and development, thus technological change and innovations could be a powerful process that opens up opportunities to increase social welfare and benefits for societies. Whether opportunities turn into real benefits and allow for broad participation depends on a number of factors. In this contribution, we focus on three questions. First, what are the drivers of and the gains from technological change? Second, is there broad participation in the gains from technological change? Third, what mechanisms generate asymmetric participation or even non-participation? Reviewing the literature, we obtain two sets of answers, one set for developed countries (DCs) and one for less developed countries (LDCs). This contribution links up to the article Innovations, Growth and Participation in Advanced Economies - A Review of Major Concepts and Findings (published in the previous issue of IEEP) in which the process of innovation as well as the effects of technological change on growth and distribution has already been discussed for advanced economies. In this contribution, the focus is on developing economies. Technology that originated in DCs is transferred to LDCs. We identify the channels of technological transfer that allow LDCs to potentially participate in the benefits. Here, the development of the modern sector with links to international value chains plays a major role. However, global diffusion of technology and its gains are very diverse. Reasons for this diverse participation in gains include power structures in global value chains combined with an excess supply of labor and the malfunctioning of local governments and institutions in LDCs.

Keywords Technological change · Global technological transfer · Structural transformation · Development · Inclusiveness

✉ T. Gries
thomas.gries@notes.upb.de; http://www.C–I–E.org

[1] University of Paderborn, International Growth and Business Cycle Theory, Warburger Strasse 100, 33098 Paderborn, Germany

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1 Introduction

Technological change is one, if not the most important, engine of economic progress and can be a powerful process that opens up opportunities for increasing social welfare and benefits to society. However, who participates in these gains? Do these opportunities of technological change allow for the broad participation of people and societies? Do societies in the advanced economies which generate global technological progress gain? And do many social groups participate in these gains? Is the transfer of technological change to lower-income economies beneficial for their societies, and do their populations widely benefit? Is there a broad participation in technological change and its benefits from a global perspective? This contribution links up to the article *Innovations, Growth and Participation in Advanced Economies - A Review of Major Concepts and Findings* (published in the previous issue of IEEP) in which the process of innovation as well as the effects of technological change on growth and distribution has already been discussed for advanced economies. In this article the focus is on developing economies. We identify the channels of technology diffusion and discuss how developing countries participate in the gains of technological transfer.

2 Perspective of developing countries

What are the aggregate gains from international technological diffusion for developing countries? Is there broad participation in the gains from technological change in developing economies?

Evidence on gains and income diversity: Measuring the degree to which developing countries could benefit from the gains from technical change is also a question of convergence and catch-up. Successful technology transfer expressed in the adoption of innovations and technologies may give less developed economies an opportunity to catch-up to advanced economies. However, evidence shows that not all countries have been catching up and that the tendency to converge is only present in groups of countries that share a similar level of development. It does not generally hold between developed and less developed countries, resulting in convergence clubs.

When looking at the issue of participation in the technology driven growth process, it is important to consider the extent and development of inequality in more than one dimensions. In the country dimension we examine income and productivity differentials between and within countries and country groups. Looking at the global dimension allows for an analysis of the extent of inequality from an overall perspective by comparing individuals.

As for the country dimension, the between and within dimensions of inequality are very different globally and over time. In general, developing economies do not participate symmetrically in the benefits of technological change. Their heterogeneity is too broad and the group too large to describe the conditions as holding for more or less all of them.

Considering the alternative global dimension, world income distribution based on individual data helps to examine which groups were able to benefit from global

development and which experienced losses. This view shows different overall income levels and large differences between advanced and developing economies, sometimes even that the upper income groups in the poorer countries reach similar income as the lower income groups in the richer countries.

When examining global inequality development over time, world income distribution derived from an integrated concept of a global Gini coefficient does not seem to have changed too much overall. On the one hand, diffusion of technology towards countries which were previously not able to use modern technology has allowed them to participate in the gains, leading to a decrease in inequality. On the other, this redistribution took place at the expense of large groups of households in advanced economies and further, it benefited the highest percentiles of world income. These neutralizing forces have led to only marginal overall changes in world income distribution measured by aggregate indicators.

What generates technological change in developing economies? How does technological change diffuse through developing economies?

The transfer of technology from advanced to developing countries mostly happens through the international value networks that operate within a modern sector. The emergence of this sector is both an outcome as well as a precondition for the process of transferring technology. For a developing country, being part of an international value chain compensates for the limitations of a missing local market and lack of technological capabilities in producing modern sector goods. The development of a modern sector is associated with a number of positive economic development activities. Labor is absorbed in domestically producing firms and aggregate productivity is increased. Further urbanization may lead to pooled labor markets, lower transaction and information costs, and easier distribution of knowledge and ideas. The tax base is increased, public sector development potentially benefits, and broader social changes can occur.

More precisely, global value networks can be divided into producer- and buyer-driven networks, both with their own characteristics. Though decision-making is concentrated in developed economies, both types of networks have the ability to outsource other tasks to a developing country. Both types diffuse technology to the country that links into the chain by giving it access to know-how and modern technologies including organizational capabilities. While in producer-driven networks, the technologies that are used and transferred may be more complex, connecting nodes may also be more dependent on one network than in buyer-driven networks.

International locations compete in the process of attracting tasks from the international value networks. Thus, local conditions are a key element in participating in the transfer of technology through value networks. These conditions include a sufficiently skilled labor base, functioning and reliable public and economic institutions, a steady power supply, a working financial sector and communication-related infrastructure, and entrepreneurial activity.

One of two major transfer channels is FDI. Foreign direct investment normally transports technology and knowledge that is embodied in the investment. It may absorb labor and lead to spill-over and forward and backward linkages if successful connections between local suppliers and the foreign direct investment are possible. Limitations occur as these investments may be very specific in terms of the embodied technology.

The other major transfer channel is independent trade, i.e., trade that does not take place between legally connected entities. The main participation in international trade

networks for developing countries takes place through imitation. Though the transfer process may be more sustainable, the requirements for linking up to an international network as a trade partner are challenging in terms of organizational, communicational, and technological capabilities and entrepreneurial skills. Also, buyer-driven networks exert competitive pressure on participating nodes.

Why do we observe large differences in the degree of participation in the gains from diffusing technological change? What mechanisms generate such large differences?

Technology transfer usually takes place within global value networks, either through FDI and firm internal trade or through trade between independent firms. Such value networks are typically not subject to perfect competition and thus give rise not only to efficiency gains but also to pure rents, which can be easily distributed towards the owners and the controlling units, which are often located in advanced economies. Participation in terms of local wages is limited due to the excess supply of low skilled labor and the lack of market power.

In the case of trade between independent firms, local entrepreneurs are the driving force behind local technology upgrading. While they generally open up opportunities for developing countries to be included in the rent distribution, strong competition in buyer-driven networks may shrink profit margins and increase the pressure on local wages. As available technologies are often skill-biased, a rise in relative demand for skilled labor may further widen wage differentials between skill groups in developing economies.

Furthermore, local governments and administrations may affect the distribution of rents through corruption, the design of trade and internationalization policy, and the enforcement of regulations, such as labor laws or health and safety standards.

2.1 Gains from technical transfer and income diversity

What are the aggregate gains from international technological diffusion for developing countries? Is there broad participation in the gains from technological change in developing economies?

In this section, we look at the effects of a transfer of technologies and technological change in developing economies. We focus on three aspects: the heterogeneity of observable trajectories of countries participating in the benefits of global diffusion of technological change (2.1.1), the global disparity of income at country level (2.1.2), and the global disparity of individual incomes (2.1.3).

2.1.1 Gains from technical transfer and diverse diffusion

Whether and how successful developing economies can adopt technologies from advanced economies is often determined by measuring convergence and catching-up. Following the convergence hypothesis, poorer economies tend to grow at faster rates than richer economies. Classical empirical convergence literature traces back the presence or lack of convergence to capital accumulation (see, e.g., Sala-i-Martin 1996; Barro and Sala-i-Martin 1992; Barro et al. 1991; Quah 1996). However, the levels of technology and technology adoption may go a long way to explain development differences and convergence dynamics. The sharing of innovations is one of the primary explanations for convergence cited by Baumol (1986). Successful technical

transfer in terms of replication of new production methods and the adoption of innovations and technologies may give less developed economies an opportunity to catch up to advanced economies.

Bernard and Jones (1996) suggest that convergence models that incorporate technology transfer provide a richer framework for the catching-up mechanism. They show that differences across countries and sectors appear to match differences in labor productivity. Building on the technology gap growth model developed by Pavitt and Soete (1982) and Fagerberg (1987), Fagerberg and Verspagen (2002) confirm the relevance of technology diffusion in the growth process. They take the distinction between the development of new knowledge and the diffusion of knowledge as their point of departure and find that it is possible for a country facing a technological gap to increase its rate of economic growth through imitation. In this process, the rate at which a country catches up to the technological frontier depends on its ability to mobilize resources for transforming social, institutional, and economic structures. Madsen (2007, 2008) investigates the importance of technology spill-over in the convergence process of total factor productivity. He argues that knowledge is transmitted internationally through the channel of trade and finds a robust relationship between TFP and imports of knowledge. Analyzing a panel of OECD countries over the period 1870 to 2004, he shows that knowledge spillovers are an important contributing factor behind the TFP convergence across these countries.

Figure 1 shows the development of GDP per capita from 1950 onwards for selected economies relative to the US. Countries like the UK, Japan, Germany, and starting in the 1960s also South Korea have caught up considerably. However, not all countries have. Some, such as Nigeria, Ethiopia, and Democratic Republic of the Congo, have even fallen behind richer economies.

Empirical research indicates that the catching up tendency is only valid within groups of countries on a similar level of development, and does not generally hold

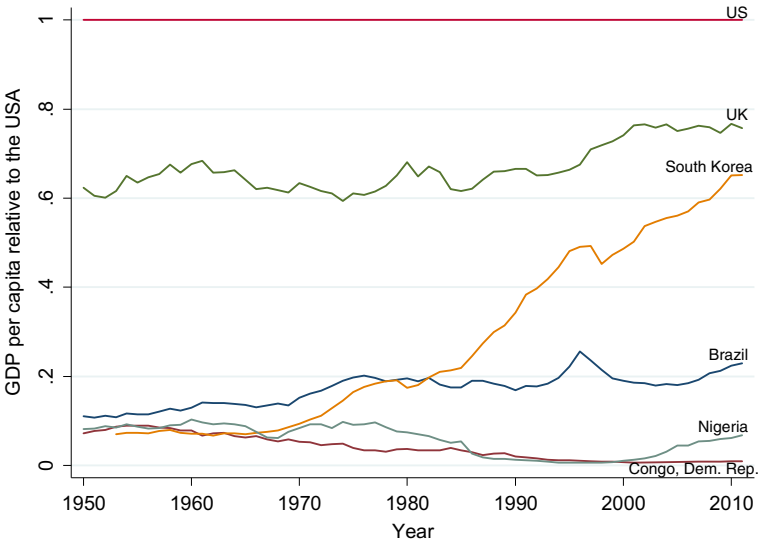

Fig. 1 GDP per capita development relative to the US. Penn World Table 8.1. Expenditure-side real GDP, using prices that are constant across countries and over time

between developed and less developed countries. The joint distribution of income levels and growth rates can be described in terms of convergence clubs. These capture the idea of multiple equilibria and a tendency towards similar growth trajectories for countries at similar development stages (see, e.g., Ben-David 1998; Quah 1996, 1997; Berthelemy and Varoudakis 1996; Canova 2004).

Figure 2 shows average GDP per capita growth rates between 1960 and 2011 along with the GDP per capita that the countries started out with in 1960. The first club of countries, which includes the US, started out with the highest levels of GDP per capita and grew at average annual growth rates of around two percent. The second club, consisting mainly of European countries, started out with medium GDP per capita but grew at slightly higher rates, thus converging slowly to the leading high income countries. The remaining four clubs all started with a rather low GDP per capita. However, they significantly differ with regard to their growth rates. The third club, which is dominated by Asian countries, experienced considerable growth and thus rapidly converged towards the leading club of high-income countries. The fourth club, which consists mainly of Latin American and Asian countries, grew less rapidly. Their growth rates are comparable to those of the countries in the second club. The fifth club, mainly including Latin American and African countries, underwent average annual growth of below two percent and thus experienced divergence from the high income countries. The sixth club, which is dominated by African countries, not only experienced divergence – it even lost per capita income in absolute terms.

Some convergence literature assumes that the catch-up process requires a certain threshold level of development including, e.g., income, openness, human capital, and infrastructure. These are prerequisites for the adoption of technological advances and must be in place in an economy before catch-up growth can occur. Their absence may make it nearly impossible for a country in one convergence club to move to another convergence club. This self-reinforcing mechanism is also discussed in the literature in

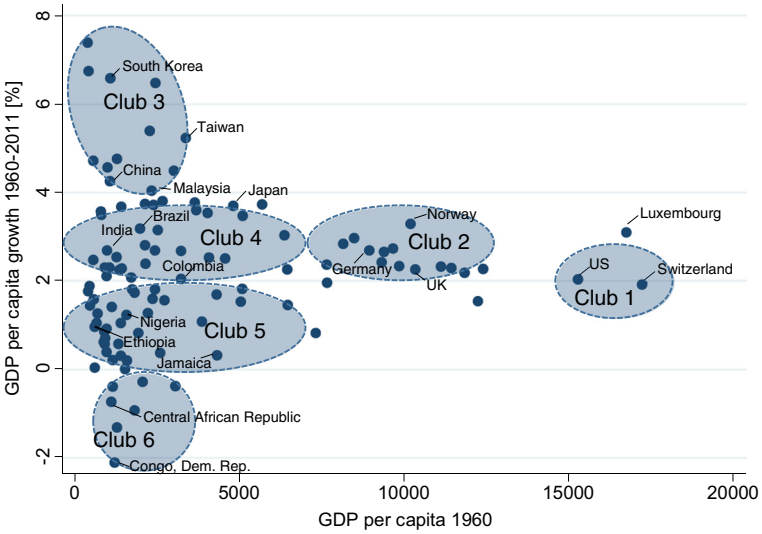

Fig. 2 GDP per capita 1960 and average annual growth rate 1960–2011 (2005 US dollars). Penn World Table 8.1. Expenditure-side real GDP, using prices that are constant across countries and over time

the context of poverty traps (see, e.g., Azariadis and Stachurski 2005; Carter and Barrett 2006; Kraay and Raddatz 2007).

2.1.2 Income disparity, country perspective

Neither do developing economies participate symmetrically in the benefits of technological change. This is obvious from the indicators describing the income distribution between countries.

Figure 3 describes the decomposition of a Gini coefficient for country groups according to Milanovic and Yitzhaki (2002). The decomposition along the "within" and "between" dimensions visualizes the following: the "between" component describes the inequality between average incomes of a group of developing countries. Hence, with this "between component" we focus on the heterogeneity of countries in the country group. That is, we look at income differences between countries of a certain group, e.g., the African countries. The "within component" takes into account inequality within a country regardless of the inequality between the countries of this group. Figure 3 shows that these two dimensions of inequality are very different globally. While Latin America is characterized by countries showing a relative homogenous average income, the distribution of income within the countries is extremely unequal. Asian countries, however, show the opposite pattern. For Asia the between part is very large while inside these countries income is relatively equally distributed.

Focusing on inequality within countries, Jaumotte et al. (2013, p.277) compare inequality between country groups and look at groups at different stages of development. They show that high-income economies have a lower level of inequality than all other groups. The highest inequality is observable for the two middle-income groups. When evaluating changes in inequality across time, all except the low-income economies show an increasing trend. Further, high-income economies have the strongest rise.

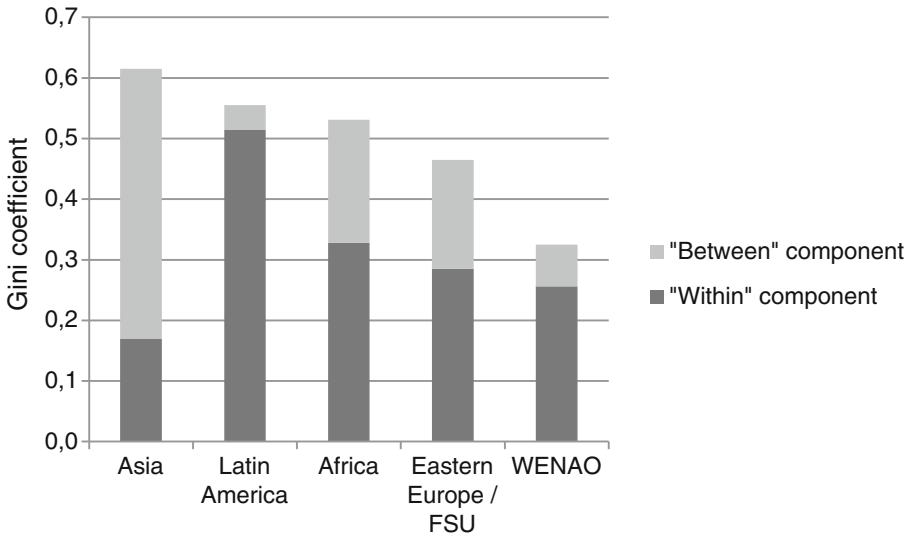

Fig. 3 Inequality by global regions, within-country Gini and between-country Gini

Comparing regions, as Fig. 4 does, inequality increased during the 1990s and 2000s for all countries considered. However, the groups did not move in the same direction. While LAC, Africa, and the Arab states reduced their Gini, that of Asia and Pacific and ECIS underwent a rise.

Therefore, unlike for advanced economies, we find substantial heterogeneity for the large number of developing economies. We thus cannot describe the conditions for this country group as being similar. What we can do is to suggest a homogenous pattern that describes the major elements of a positive trajectory. These elements are observable, some in one group of countries, some in another. Some countries are characterized by a combination thereof. However, there is no country that is fully described by this narrative. We therefore refer to it as a benchmark trajectory to discuss the process.

2.1.3 Global income disparity, individual perspective

While the issue of participation has so far been discussed within the technology driven growth process of countries and country groups, it is worth to take a global perspective which allows us to compare individuals. So far, the discussion has largely focused on income and productivity differentials either between or within countries. Differentials between countries compare averages of per capita income for each country. Studies focusing on within-country differentials attempt to explain income differentials within an economy. Considering world income distribution and the question of which groups could benefit from global development opens up an alternative perspective. Hence, recent contributions have tried to take such an integrated view (Milanovic 2011, 2013; Bourguignon and Morrisson 2002; Lakner and Milanovic 2015). Taking this perspective, we can assess who gained and who had to experience losses.

In an integrated global view individuals are considered global citizens.[1] Hence, a global income distribution for all citizens no matter what their country of origin can be described. The integrated global perspective yields some insights about the ranges of overlapping income levels. If two countries have different overall income levels, then it is still possible for the upper income groups in the poorer country to have a similar income as the lower income groups in the richer country. Figure 5 illustrates this overlap by presenting the deciles of selected (sub)national income distributions along with the respective percentiles of the global income distribution. It shows that only about the richest ten percent of the Chinese urban population have an income as high as the upper bound for the poorest ten percent in the US. For Brazil, only about the richest 30% of the population reach this income level. Given the large populations of urban China and Brazil, this represents about 57 million people each, which clearly indicates how economic changes in these countries affect world income distribution.

Milanovic (2013) presents a "world" Gini coefficient derived from such an integrated concept for world income distribution and shows the degree to which global income distribution is more unequal than that of any representative country.[2] More interesting than the pure level of the Gini is the development over time. The results indicate that there has been barely any change in world inequality during the last two

[1] Milanovic combines individual or household surveys from across countries and seeks to make the data comparable. However, as survey methodologies and procedures vary, there are limitations.

[2] That the global income distribution is larger than that of any country should be almost by definition true.

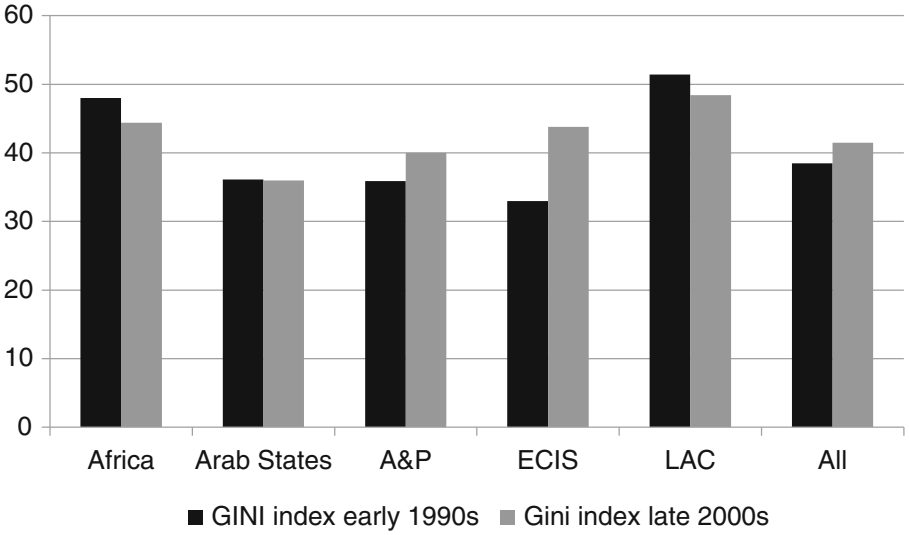

Fig. 4 Development of the Gini coefficient for different regions (early 1990s and late 2000s)

decades, measured by the global Gini coefficient. Moreover, Milanovic (2013) discusses changes in the world Lorenz curve. Comparing the Lorenz curves for 1988 and 2008, he shows that the two curves are very similar. Thus world income distribution described by this measure does not seem to have changed too much from an overall perspective. However, the two curves intersect somewhat further to the right than the 80th percentile and hence indicate some relative changes. That is, up to this percentile the average of the accumulated income share was higher in 2008 than 20 years before. However, with the Lorenz curve we cannot see the redistribution within the lower 80%.

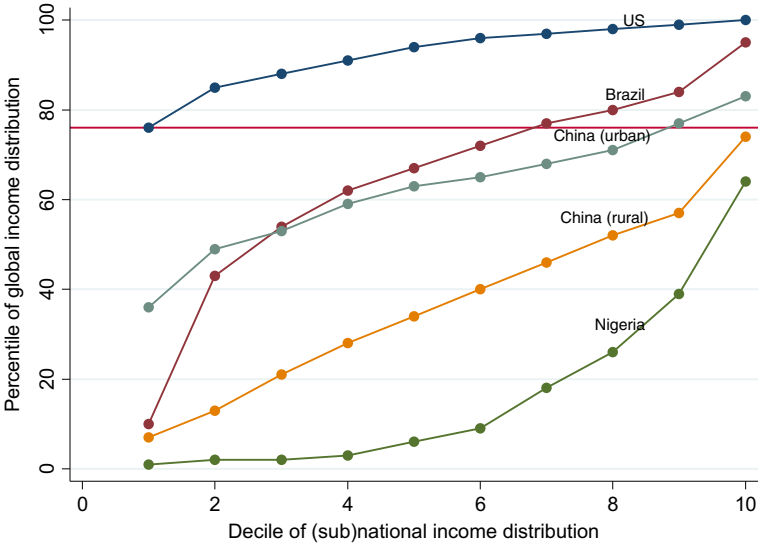

Fig. 5 (Sub)national income deciles within global income distribution. Based on the Lakner-Milanovic World Panel Income Distribution database, see Lakner and Milanovic (2015)

Turning to the "rich" end of the income distribution, another pattern appears. In 2008 the upper one, five and ten percentiles earned a larger share than in 1988, illustrating a redistribution in favor of the highest percentiles of world income. That is, even though the Lorenz curve in general does not show dramatic changes we can identify relatively winning groups, leading to a change in the structure of the world income distribution.

Lakner and Milanovic (2015) further explore this pattern and consider real income growth within fractile groups of world income distribution between 1988 and 2008, as presented in Fig. 6. they show that starting with the 10th percentile, income groups up to the 70th percentile increasingly gained, with the strongest gains between the 40th and 70th percentiles. Diffusion of technology towards countries which before were not able to use modern technology is likely a major reason for this decrease in inequality (Firebaugh and Goesling 2004). In particular, large emerging market economies, notably China, contributed to the gains of this income group and therefore more equal world income distribution (Milanovic 2013; Bourguignon and Morrisson 2002; Davies et al. 2007; Ferreira and Ravallion 2008). In China both, poverty was reduced due to reforms in the agriculture sector. Strong industry growth enabled a significant share of labor force to obtain jobs with higher productivity and higher income (Khan and Riskin 2001; Fan et al. 2004; Meng et al. 2005; Dollar 2007). This positive development in emerging markets, however, contrasts with difficulties experienced by large groups of households in advanced economies, Latin American or former Communist economies (Milanovic 2013) and the fact that the very rich gained extraordinarily. Therefore, we see forces which may neutralize each other, leading to only marginal overall changes in world income distribution.

The upper 35 percentiles of world income distribution represent to a large extent households in advanced economies. Except for the very rich, most of these groups are far below the global mean growth rate. According to the discussion in Part I of this

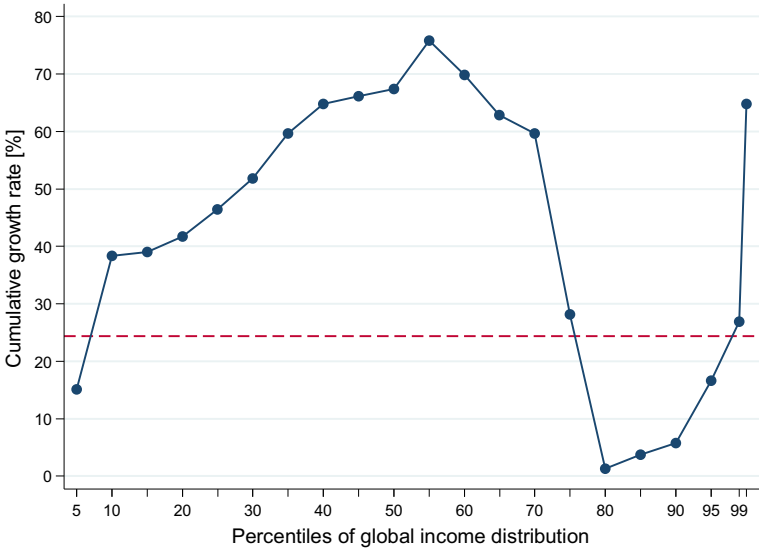

Fig. 6 Real income growth within fractile groups of world income distribution between 1988 and 2008. Based on Lakner-Milanovic World Panel Income Distribution database, see Lakner and Milanovic (2015). The horizontal line indicates the cumulative growth rate in global mean (24.34%, i.e., 1.1% p.a.)

paper, they are under pressure from two sides. Both skill-biased and routine-biased technological change and competitive pressure from internationalized production seem to be the driving forces behind the difficulties of these income groups. The fact that large groups in these countries are falling behind sheds an interesting light on the current functioning of the advanced economies in particular. While we do not observe that advanced economies are on average in a difficult situation, there are large differences within. The highest income groups are still gaining massively relative to other groups in the country or worldwide. Middle and low income groups have relatively fallen behind, possibly because they are not participating in the overall benefits of technological change. The most alarming fact, however, is that the poorest five income percentiles gained absolutely only very little (just about enough to reduce absolute poverty) and lost massively in relative terms. So even if progress has been made in reducing poverty during the last decades, the lowest five percentiles have still not been able to participate equally in global income gains.

Next, we exemplarily consider how the position of selected (sub)national income groups in the global income distribution has changed over the course of time. Figure 7 shows how the whole range of Chinese income groups shifted up in the global income distribution between 1998 and 2008, i.e., all income groups in China were able to improve their relative income position in the global context. Figure 8 in turn shows the negative development for Nigeria between 1992 and 2009. While Nigeria's low-income groups remained at the bottom of the global income distribution, the middle income groups strongly shifted further down the global income distribution. The high-income groups also shifted down, yet not as dramatically. It thus becomes apparent that there have been winners and losers among developing economies and that within some developing economies the development of income groups has been rather symmetrical, whereas others faced an asymmetric development between (sub)national income groups.

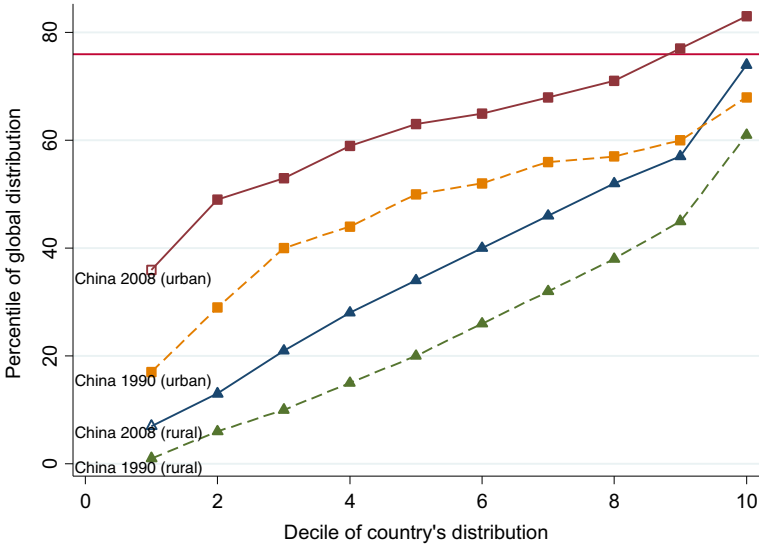

Fig. 7 Subnational Chinese income deciles within global income distribution. Based on Lakner-Milanovic World Panel Income Distribution database, see Lakner and Milanovic (2015)

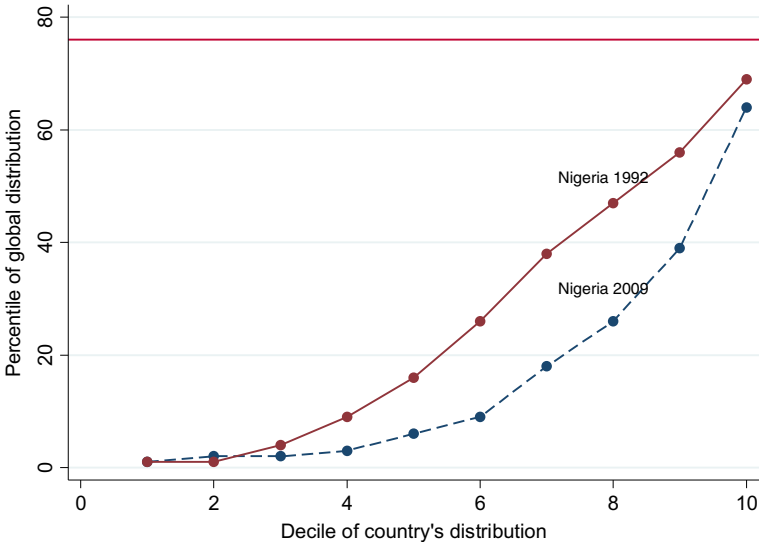

Fig. 8 Nigeria's national income deciles within global income distribution. Based on Lakner-Milanovic World Panel Income Distribution database, see Lakner and Milanovic (2015)

2.2 Transfer of technology to developing countries

What generates technological change in developing economies? How does technological change diffuse through developing economies?

We identify five channels of technology diffusion. Technical diffusion requires a modern industry sector (2.2.1). The globalized firm is the main vehicle for technology diffusion (2.2.2). Modern sector development and linkage to international value chains require sufficient positive local conditions in developing countries (2.2.3). If these conditions are in place, foreign direct investment (2.2.4) and trade relations (2.2.5) enable technologies diffuse to the local modern sector in the developing country.

2.2.1 Industry growth towards a modern economy and society

Transfer of technologies and links to international value networks are major drivers of modern sector development in developing economies (Gereffi et al. 2001; Gereffi and Memedovic 2003; Makki and Somwaru 2004). Why are links to international value networks and modern sector formation important? Countries in the early stages of development, which are characterized by a dominant agricultural sector or a semi-agricultural economy, face two problems. One concerns the demand side, the other the supply side. On the demand side, in many smaller countries a large share of the population lacks the income and productivity it needs to purchase goods produced in a modern industrial sector. There is no domestic market either for final products or intermediate goods or tasks for a value chain in industrial production (Tybout 2000). On the supply side, even if there is a market for some goods, countries often do not have the technology, product quality, and/or organizational ability to offer domestic customers a competitive product. Thus, a simultaneous lack of market and technological capability erects a prohibitive barrier to developing a domestic modern sector.

From the perspective of a small developing country, linking up to the international value chain breaks both limitations. First, for these countries the world market provides an almost unlimited demand for products conditional upon the ability of the country to adjust to technological standards, qualities, and requirements. Second, the ability to adjust to these requirements can potentially be imported if such links can be established. Such a link makes the technologies and knowledge elements available which previously hampered the development of a modern sector.

Furthermore, the manufacturing sector is an important driver of productivity in developing countries. Since the 1950s it has grown more rapidly than the primary sector (Szirmai 2012). Further, it absorbs labor and is capable of tapping into world markets. Amongst other factors, these make it the quintessential escalator for development (Rodrik 2014). Adapting local technology to a global value chain allows a modern sector to participate in technological change and be a catalyst for development.

At least two potential positive processes are associated with manufacturing, regardless of whether they are conducted by entities owned by foreign firms or by independent local firms. First, backward and forward linkages help to spread technologies into the local economy (Javorcik 2004; Liu 2008). The local economy can link to international nodes and take over tasks in global value chains, including the production of further intermediate goods. Second, the interaction between global networks and the local economy may cause additional learning. The literature on learning through exporting suggests that productivity gains may arise from buyer-seller interaction in terms of technical assistance from overseas buyers, as well as increasing incentives for managerial effort, which would not arise in a closed economy. More importantly, productivity increases after companies start to export, which suggests that there is not just self-selection of more productive firms into exporting, but an actual increase in productivity from exporting (Blalock and Gertler 2004; Van Biesebroeck 2005). Local human capital improves; additional productivity gains are the result. We can thus expect positive firm or sector trajectories in economies linked to international production networks.

Let us draw a scenario which describes the more optimistic trajectory before we turn to the shortcomings of participation. The optimistic path is related to strong linkage in the domestic economy. The technology transfer not only affects the node in the international production network. Potential demand and the ability to imitate international technologies opens up opportunities for the local economy. Domestic entrepreneurs take up these opportunities and translate them into starting-up firms or growth of existing firms. Entrepreneurs define the link to the local economy and are the key driver of the development of a formal modern, higher productivity sector (Brixiova 2010). This growing formal industry sector absorbs labor supplied by the Lewis labor pool (Rodrik 2016). That is, labor abundance and comparative advantages in labor intensive tasks enable local firms to generate jobs and in turn, reduce the most serious problem, namely lack of employment. However, generating more jobs is not the only important effect of such modern sector development. The switch from jobs with very low productivity to relatively highly productive jobs is also crucial (McMillan et al. 2014). Structural change implies a "bonus" attached to aggregate productivity (Temple and Wößmann 2006). By developing an industrial sector and jobs therein, not only are a large number of people included in the growth process – the creation of jobs, average productivity growth and higher wages will also enable employed labor to

increase their family income. Thus, created income spreads further than only towards employed labor. Furthermore, higher productivity also alleviates poverty. Even more important than the direct effects could be the indirect learning effects.

The transformation of the economic structure also leads to urbanization. The fast growth of urban agglomerations is clearly observable in this respect.[3] Urbanization and agglomeration are associated with several advantages. Larger markets may lead to more specialization and scale economies, labor markets may be pooled, suppliers have a broader variety of costumers and can pool risk, and lower transaction and information costs allow an easy diffusion of ideas and knowledge (Puga 2010; Gries and Naudé 2008). These are attributes of well-organized urban development. By "urbanization" we do not mean slum cities which can be regarded as a contrasting system to what we discuss in this positive scenario. Hence, we must remain aware of the very different qualities of urbanization as we further develop and discuss this transformation process.[4]

Further, the evolution of a modern formal sector gives the government a tax base and allows for a sufficiently paid public sector, which may become less dependent on bribes. A sufficient tax base also enables the government to improve institutions, economic, administrative, and political institutions. With a large and growing group of people participating in economic development, the political culture may be also affected. A broad and inclusive base of entrepreneurs and a growing middle class may be able and willing to participate in the political process, too. Paying taxes gives these economic successful groups the self-confidence to also take over responsibility in political decision making. Political participation may follow economic participation, if preferred by a society that follows such a successful ideal economic path.

Further, social transformation may also lead to a demographic transition. A growing modern sector induces higher labor market participation of women and influences their choice between the number of children they want to have and their educational level. Due to better earning opportunities parents will want their children to receive more education and, in combination with the quantity-quality trade-off, a growing modern sector may induce fertility decline. Dropping fertility rates further allow resources to be shifted towards better education for children and thus enhance human capital formation and labor productivity. Thus, a growing modern (export) sector is likely also a major determinant of fertility and demographic transition (Galor 2012; Gries and Grundmann 2014, 2016). With the demand for secondary education in the modern sector, a family will want more qualified children with higher productivity and high earnings. In an urban modern sector for substantial family support qualified human capital is more important than the number of children. This holds for both support types: direct family income and family risk insurance. Thus, fertility decreases and human capital investment increases simultaneously. Demographic transition follows a similar pattern, as known from the advanced economies.

Overall, developing economies can benefit substantially from linking up to international value networks in the various dimensions elaborated above. The transformation of the economic structure opens up important opportunities for sustainable

[3] As we are describing a positive trajectory, "urban society" means a center as described in regional economics, i.e., a location providing infrastructure, public goods, public transportation, a modern industry and service sector with positive inter-firm and intra-sector externalities, sufficiently developed housing capacity, and a center of higher and highest education.

[4] For an account of different qualities in urbanization see, e.g., Gollin et al. (2016).

development and a catching-up trajectory towards the advanced economies (cf. section 2.1.1). Apart from purely economic transformations, in urban centers we also observe a societal transformation, away from rural, traditional rules towards an urban society. However, this transformation is a cultural revolution that is painful for existing societies. It offers major potentials for conflict as traditional beliefs, rules and rulers are losing power in favor of new (and secular) counterparts. Most prominent is the change in the influence of religion and the role of women in public and private life.

Why is the development of the modern sector superior to the development of the traditional agricultural or primary sector? The answer lies in three unlimited growth potentials. There is no natural limitation in the growth of (i) the number of firms, (ii) the value of firms, and (iii) the employment of labor.

The unlimited growth in the number of firms addresses the following: A firm can be started as soon as an entrepreneur discovers a need for which a customer has a willingness to pay for. This means that as long as there is demand, capital and labor can be combined (in start-ups) to satisfy it. Ideally, talented entrepreneurs find an opportunity, acquire the necessary resources and labor, and obtain funds to realize their business idea which eventually turns into a successful firm. This provides an opportunity for an unlimited number of entrepreneurs to transform their vision into an economic process which can be fed by capital accumulation and innovation without physical limits. A modern sector can offer ample opportunities for talented entrepreneurs. In a producing, growing and successful economy they take on productive positions while in the situation of falling short of productive opportunities talents may choose to become rent seekers instead of producers (Murphy et al. 1990).

Similarly, if a start-up is successful there is (in principle) no limit to firm growth. A successful business idea leads to a firm that can expand until market limits are reached and even beyond by tapping into new markets. Industrial firms can accumulate an infinite value of productive capital out of a business idea and opportunity. Capital can be accumulated or taken from the capital market and labor is absorbed as needed.[5] This latter mechanism is particularly important for developing countries.

The most important problem in developing countries is the pool of unemployed labor that seeks sufficiently productive occupation. Which kind of production process can absorb this kind of excessive supply of labor over the long term? Only the modern (often manufacturing) sector has this potential capacity (Rodrik 2014). For the agricultural sector, land is the crucial factor. It can use only a limited amount of land. Even if the value of this limited space could continuously grow as capital stock, its ability to absorb labor is limited (Estudillo et al. 2013). That is, on the one hand farmland shows characteristics that are comparable to other forms of capital, such as potentially unlimited growth in value. On the other, there are clear limitations with respect to the creation of employment. Figure 9 shows correlations between sectoral employment growth and overall employment growth at different developmental stages. The positive relationship between sectoral employment growth in agriculture and overall employment growth clearly breaks down for higher middle income countries, while the modern sector maintains its important role. An agriculturally dominated economy can potentially grow in value, driven by land productivity and the value of land.

[5] Gries and Redlin (2011) support the idea of surplus labor as introduced by Lewis (1954) and show that labor is not a restricting growth factor in China.

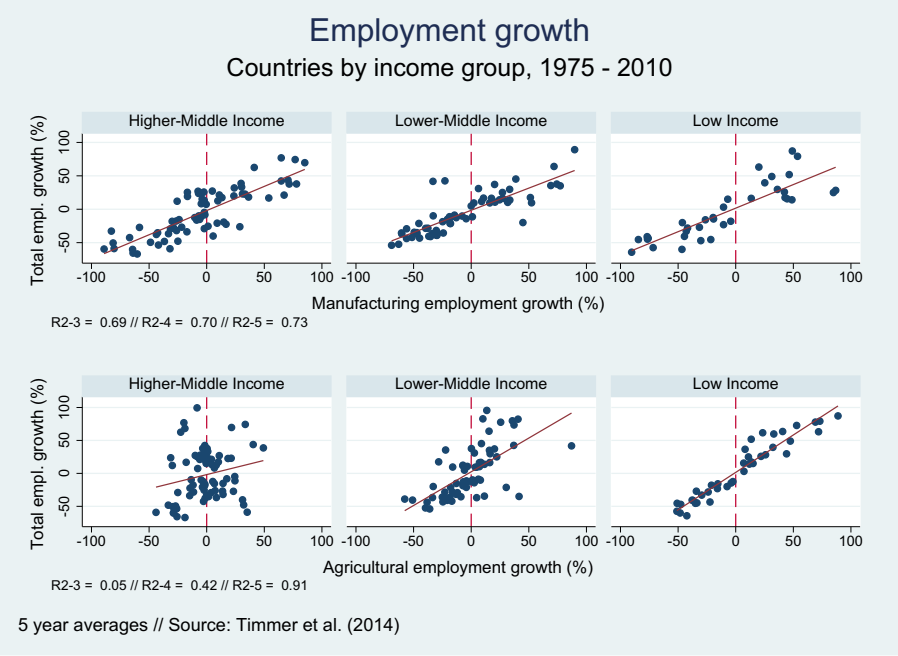

Fig. 9 Correlation between sectoral and overall employment growth. Based on data from Timmer et al. (2014a, b)

However, this growth includes only the limited volume of agricultural labor. Also, if there is a Lewis labor pool the gains from productivity growth are allocated to an even smaller number of land owners.

2.2.2 The globalized firm and technological linkage between advanced and developing economies

Approaching the firm as a controlled network, we can explore the linkage between the evolution of global production networks, the role of network leaders in transferring know-how, and the formation of capabilities by local suppliers to such networks. Global value chains may be classified as producer-driven or buyer-driven networks. In the first, a producer is the strategic and technological center of the network (e.g., in automotive, aircraft, computer, or heavy machinery manufacturing) that controls the value-generating processes (including the organization of forward and backward linkages). This type of production is typically characterized by high entry barriers since production is technology-intensive and requires economies of scale. In the second, large international buyers exert control by capturing strategic positions in marketing and design (e.g., in garment, footwear, toy, or homeware production) (Gereffi 1994, 1999, 2001; Gereffi and Memedovic 2003).

Neoclassical trade theory suggests that firms in countries produce final products. After opening up to trade, firms in different industries or sub-industries realize comparative advantages and hence we can observe certain export and import patterns. These comparative advantages may be due to differentials in technologies or factor

abundance. However, this trade theory explains trade for countries with large differences in fundamental characteristics. Such fundamental differences can be identified, e.g., for advanced and developing countries. Hence, the question is how does international economic integration work under today's conditions and what is the role of technologies in this process in determining whether or not the dynamic pattern of trade and structural transformation leads to broad participation in the benefits of technical progress?

Neoclassical trade theory can be easily transferred from trade in final goods to a trade theory that accounts for today's view of the firm and the conditions in a globalized production network. There are four major reasons why value generation became significantly more globalized during the last three decades. The first main reason is that the diffusion of technologies, originally introduced in the advanced economies, is continuously shifting to developing countries. Second, a massive drop of trade restrictions and financial barriers led to easy cross border transactions in almost all regions of the world. Third, the broad introduction of information technologies led to a new type of firm organization,[6] and fourth, to a further reduction in shipping costs. These trends contributed to massive expansion of trade and a global allocation of intermediate products and tasks which are controlled by value networks. Figure 10 shows the increase in value added in global value chains that is generated by emerging and developing economies according to a new metric by Timmer et al. (2012). In contrast to traditional competitiveness indicators such as export shares, it indicates the extent to which a country can compete with other countries in terms of tasks within global manufacturing rather than products. Most strikingly, China experienced a five-fold increase in manufacturing value added between 1995 and 2009. Brazil, India, Mexico, and Turkey also show large absolute increases in global value chain income.

Global value networks have supported international diffusion of technologies and opened up opportunities for local development in developing countries. Local suppliers participating in a foreign-led global production network have access to know-how and modern technologies and are thus able to upgrade their technological and organizational capabilities. Participating in global value networks however requires quick response times, the fulfilment of quality standards, and financial solidity (Ernst and Kim 2002). Linking to a global production chain affects the technology, imitation, and upgrading conditions for local production clusters. The chance to locally upgrade depends on the type of network a local supplier feeds into (Humphrey and Schmitz 2002).

Governance is of major importance in such global value networks as the governance structure determines the distribution of rents between the value-generating nodes in such a network. Capabilities of supply bases, the complexity of transactions, and the ability to undertake transactions are in turn the major elements that determine the governance structure of global value chain networks (Gereffi et al. 2005).

With the definition of tasks or nodes it becomes very easy to think of within-firm tasks or nodes (local and international) and out-of-firm externally owned nodes. It becomes also easy to think of domestic value generation in different locations, including international sourcing of tasks. In such a value network there is a central node or a small set of nodes that define the center and a periphery of needed but less important

[6] See section 2.2.2.

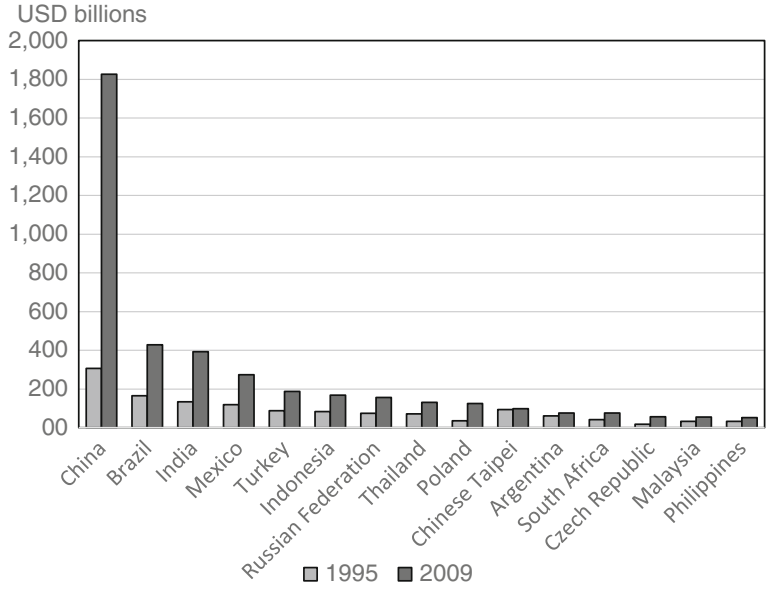

Fig. 10 Value added in manufacturing global value chains in selected emerging and developing economies, 1995 and 2009 (based on OECD (2013)/OECD-WTO Statistics on Trade in Value Added)

nodes to define the firm's characteristic capabilities. As described above, such a central node stands for head office and strategic management.[7] It represents a firm's current capability developed through experience and knowledge accumulation. Hence, the de facto head office (i.e., the center for strategy and governance) of most transnational firms is located and governed in advanced economies. At this central node, decisions on sourcing are taken.

What are the sourcing questions faced by the central node? First, which nodes are to be positioned within the firm or outside the firm? That answers the question which tasks and services are produced by the firm itself, or which tasks are to be outsourced and imported from other firms. It is a question touches upon not only ownership and control but also on the transfer of knowledge. Whether multinational firms create technology spillovers depends, among other factors, on whether the production network is producer- or buyer-driven. In producer-driven networks the task are often very specific and specialized. Hence, completely specialized nodes are dependent on one network and clearly directed and controlled by the foreign firm. Input and output is fully predetermined. However, such integration into the international value chain by producing a more complex technological good gives often access to more advanced technologies. Due to the skills required for these kind of production processes, such nodes are likely to be already located either in more advanced regions of developing economies or emerging economies. This opens up an opportunity for the transfer of even more complex technologies. In buyer-driven networks, processes are less specialized and often also less sophisticated. With a lower complexity of the technology, fewer and simpler technologies are transferred. However, as the technology is mastered by the

[7] See O'Donnell (2000) for an overview of literature on how multinational corporations are managed and a test of competing organizational theories.

local firm it becomes less dependent. The local firm becomes able to substitute its link to an existing value network with another.

Second, the decision on the sourcing of tasks touches upon where a certain task is located around the globe. Which nodes are best produced in the firm's home country, which internationally? International production can be the result of either FDI or of an imported task from a foreign producer. International sourcing does not just mean assigning a certain task to a certain location. For the globalized firm the key element of international sourcing is linking up the firm's technology and know-how with the comparative advantages of a production process in a certain country. Thinking of outsourcing and offshoring in terms of a disaggregation of the value chain, the optimal location of the value chain components is determined by the interplay of comparative and competitive advantages (Mudambi and Venzin 2010). With this new combination, the firm at least gains efficiency and often also additional rents. Both are important elements in the permanent struggle to remain internationally competitive. Both elements also increase the firm's income that can potentially be distributed to different groups of stake holders within the firm.

In light of the above, it is not surprising that we have been able to observe such a massive wave of globalization over the last three decades. When the sourcing decision is done, each node is allocated according to country- or region-specific comparative advantages. Hence, the tasks of the production chain are spread all over the globe. At least in an early stage of development, these sourcing decisions often define the link between advanced economies and industry development in developing economies. These decisions strongly influence the crucial transfer of technologies and know-how that enables developing countries and regions to become part of a global value network. This technology and know-how transfer enables the lagging industries to match current standards and qualities so they can access the market for tasks related to modern (non-primary) sector value adding. In the later stages of development, this technological link is often substituted by an imitation process. In this imitation process, domestic entrepreneurs substitute for the function previously occupied by MNEs. In this stage domestic entrepreneurs increasingly organize this link to the international value chain independently and upgrade technologically by imitation.

2.2.3 Local conditions for attracting technology transfer

Having discussed the importance of developing a modern sector and the transfer of technology opportunities within global value networks, a pressing question remains: what needs to be put in place so a network node in a developing country can emerge? Local conditions are crucial for integration in global production processes, international connectivity, and ultimately for convergence and catching-up.

International connectivity is a necessary but not sufficient condition for modern sector development. Access to international value chains and markets is partly subject to external conditions. Sufficiently favorable local conditions in the emerging modern sector of the developing economy are required to attract and enable technology transfer from an advanced economy, such that tasks within international value networks match potential competitive nodes in developing economies. What are these local conditions that can promote international connectivity for a modern sector in a developing country?

Even if many locations offer the right environment for a successful node, a number of local conditions are typically important for a successful realization of comparative advantages and for the location to become able to achieve technology transfer and its benefits (Coe and Helpman 1995; Coe et al. 1997, 2009).[8] These are (i) a sufficient level of skilled local labor and human capital (Barro and Lee 1993; Barro and Sala–i–Martin 1995; Schulz 1999), often with at least secondary education; (ii) sufficiently functioning public institutions and public policy (Collier and Gunning 1999; Easterly and Rebelo 1993; Landau 1986; Barro 1990; Hall and Jones 1999), market and economic institutions such as property rights or freedom of contract, administrative institutions with little corruption and reliable contracts, legal institutions and law enforcement; (iii) general stability, predictable policies, and a stable political system (Przeworski and Limongi 1993; Fischer 1992); (iv) a reliable power supply, a local transport infrastructure that allows for mass transit, and often proximity to a port for shipping; (v) a working financial sector (King and Levine 1993; Gries et al. 2009); (vi) local communication infrastructure offering telecommunication and internet access; and (vii) entrepreneurship (Gries and Naudé 2010, 2011) if the link is to be organized by local firms.

The necessary local conditions may vary depending on the type of the international value network. Specifically, it makes a difference whether the international network is a producer-driven network or a buyer-driven network. A producer-driven network often sources specialized and more complex tasks under the direct and very detailed control of the central node. Buyer-driven global value chains represent an internationally dispersed production system characterized by strong competition and local ownership (Gereffi 1999).

The ability to adopt technology and hence catch up and its connection to domestic conditions are also discussed in the catch-up and convergence literature. For example, Abramovitz (1986) and Temple and Johnson (1998) emphasize the need for "social capabilities" to benefit from catch-up growth. These include an ability to attract capital and open up to global markets and hence absorb new technology. Verspagen (1991) suggests that to assimilate knowledge from abroad, a country must be able to apply this knowledge in its own economic system. These technology spill-overs require an intrinsic learning capability (depending on the education of the labor force and the quality of the infrastructure), and the technological distance between the technology-receiving country and the technological leader. In line with this, Sachs and Warner (1995) show that convergence is contingent upon efficient economic policies and the integration to the global economic system. Ang et al. (2011) investigate the relevance of human capital in the technology catch-up process and find that while primary and secondary education is more suitable for imitation, tertiary education is more appropriate for innovation. Similarly, in Szirmai and Verspagen (2015) the level of education is important for the development of a manufacturing sector in developing countries.

If these conditions are important for linking the domestic economy to a global value network, what are the major channels that help it to integrate into a global production chain? How can a producing entity become a node in the international supply chain?

[8] Kumar and Russell (2002) find that technology transfer is important for general efficiency gains, but that capital deepening is more important for convergence.

2.2.4 FDI as a channel for technological change in developing economies

In the current context, FDI is interpreted as the implementation of a sourcing node at an international location within a value network. The purpose of the FDI we consider here is industrial production of an (intermediate) good or task, not the development of a new market or penetration of an existing market.

Figure 11 shows that manufacturing in international locations has strongly increased over the last 30 years. MNEs have globalized their production activities. Furthermore, developing and transition economies are included in this global production. Figure 12 shows FDI-receiving country groups and clearly indicates that developing and transition economies are increasingly targets of overseas direct investment. Figure 13 shows how FDI flows are distributed among global regions and presents a similar picture.

Via international investment, technology or knowledge that is embodied in the investment is transported to the target country. Hence it may lead to a technology and know-how transfer (Glass and Saggi 1998; Keller 2004).[9] However, the quality of this technology or know-how transfer can vary greatly. Technological linking-up has a number of implications for the host country of the node that is integrating into the global value chain:

(i) The use of a technology can be directly transferred to the international location in a LDC country, e.g., setting up an assembly line via FDI.
(ii) Technologies can be wholly or partially directly transferred to the other country location which is controlled by the local branch.
(iii) Technology spill-overs may occur as a complementary effect.
(iv) New technologies require human capital so encourage local investments in human capital.
(v) Linking up to global value chains creates a link to a specific set of technological solutions and causes technological dependence. Periphery nodes have to adjust to the technology used in the chain.
(vi) An adjustment to the quality standard is required; the conditions are defined externally.
(vii) A technology developed subject to the conditions and requirements of the advanced economies may not perfectly fit in with the conditions of the (node-receiving) developing economies.

However, as in developing economies there is not necessarily other technology available. The effect of a region being a destination of an industrial production task (FDI) is principally positive.[10] Empirical findings suggest that FDI is an important vehicle for technology transfer if the host country has a minimum threshold stock of human capital (Borensztein et al. 1998).[11] The international investment creates jobs and

[9] See Görg and Greenaway (2004) for a literature survey on the spill-over effects of FDI.

[10] Borensztein et al. (1998) show in a theoretical model how FDI increases long-run growth rates by inducing technological diffusion from advanced economies to host countries. Xu (2000, p.491) finds that "the level of human capital is crucial for a country to benefit from technology spill-over of MNEs…. These results are also consistent with the findings of single country studies that the technology spill-over effects of MNEs are positive in advanced countries and insignificant in less developed countries". Gries (2002) suggests a theoretical model of catching-up through technology transfer by FDIs.

[11] The dynamic regression results of Carkovic and Levine (2005) and the dynamic panel causality tests of Nair-Reichert and Weinhold (2001) confirm a strong positive effect of inward FDI on GDP growth, while Hansen and Rand (2006) find a bidirectional causality between FDI and GDP levels in developing countries.

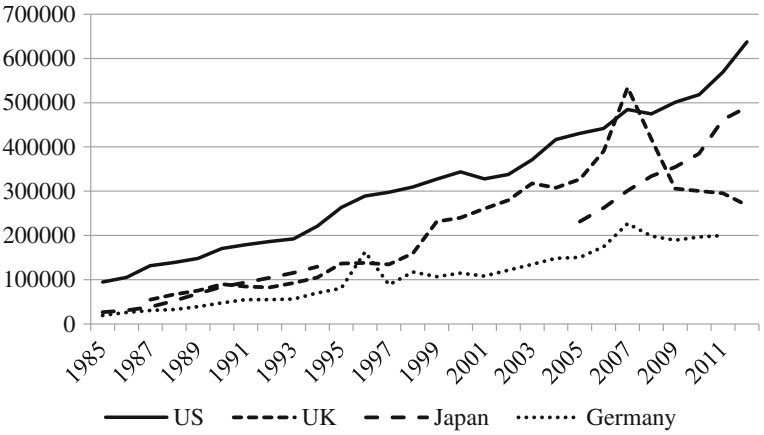

Fig. 11 Outward FDI in manufacturing 1985-2012 (in millions of US dollars). OECD (2015)

absorbs labor from the Lewis labor pool. There may also be spill-over and forward and backward linkage effects if entrepreneurial ability enables a connection to the foreign firm and its technological requirements. For China, e.g., FDI led to technology transfers to Chinese manufacturing firms (Gries and Redlin 2011).[12] Two effects occur: a level effect that lowers the domestic productivity level in the short run, and a rate effect that increases productivity levels in the longer run. Backward linkages appear to be the most important channel (Liu 2008). Linkage effects on the host country increase with the cost of communication between headquarters and production plants (Rodriguez-Clare 1996).

Still, these overall positive effects can be restricted. Often the technology transfer consists of an assembly line that executes a specific task for the international value chain. The assembly line was introduced years ago in the production process of the advanced economies. It back then represented the up-to-date technology under the wage-return conditions. Due to continuous technological change in the advanced economies, this investment and the embodied technology vintage has depreciated over time. As a result, the same machine with the same number of employed workers would now – after depreciation of the machine –cost much less and hence could be sold or reinstalled as a labor-intensive capital good.

There is an optimal "switch point" at which a technology vintage is completely depreciated in the advanced economy and ready to be transferred to the developing country. This switch point is determined by the wage and capital price for the replacing capital and technology. Hence, capital with the embodied technology vintage transforms via depreciation from capital-intensive to labor-intensive. This already depreciated capital with the embodied old technology vintage becomes the base technology for a labor-intensive production node in the developing country. The node often belongs to a producer-driven network.[13]

[12] Gries and Redlin (2011) also show that FDI into China create technology spillovers and is a part of the technological catching up process driven by international integration.

[13] Mazumdar (2001) find that while investment in domestically produced equipment reduces the growth rate in LDCs, investment in imported equipment increases it.

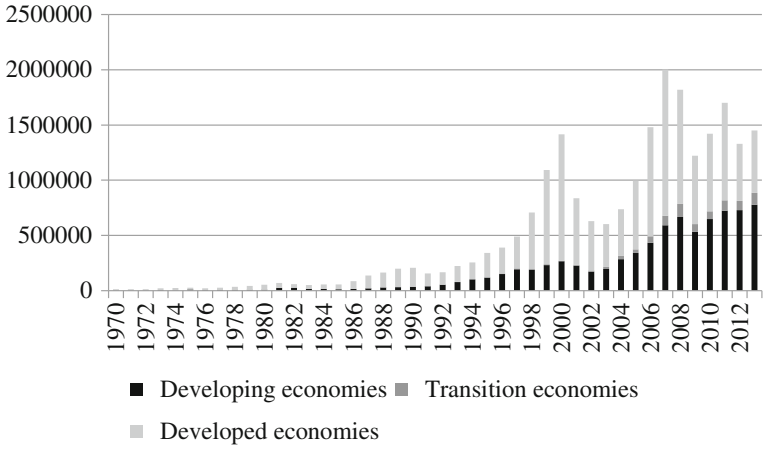

Fig. 12 FDI inflows by country group, 1970-2013 (in millions of US dollars). UNCTAD (2014)

The advantage is that this technology stems from the existing producing network and hence is compatible with this network. The disadvantage is that the depreciated and hence labor-intensive capital is not easily reproducible. Therefore, only a limited amount of capital can be used in this way. Hence, the job creation potential is also limited. This becomes even more serious as the next generation of machine vintages is transferred due to the direction of technological progress in the advanced economies and uses even less labor.

Hence, even if existing labor intensity were still competitive and highly productive, the installation of capital goods from advanced economies would limit the creation of jobs. As long as there is no sufficient investment good industry that specifically constructs high-quality capital goods and technologies that fit more precisely to the labor abundance in developing countries, labor absorption effects of capital accumulation are lower than possible. Another disadvantage of a technology transfer via FDI is that by definition, the control of the process and the transfer are in the hands of the foreign investor.

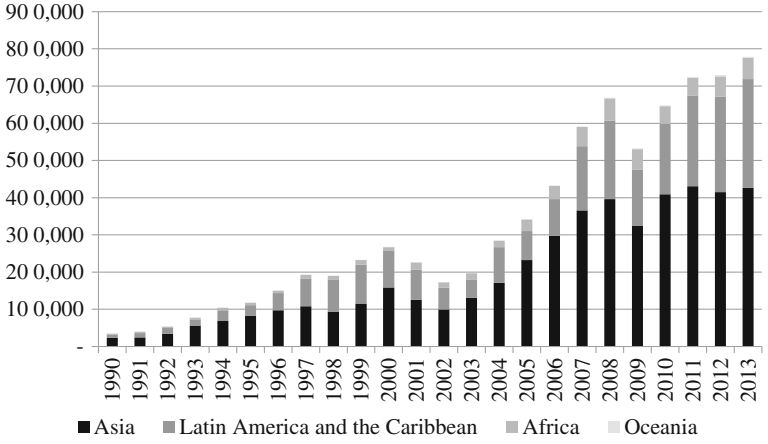

Fig. 13 FDI inflows in developing economies, by region, 1990-2013 (in millions of US dollars). UNCTAD (2014)

A disadvantage in technological terms could be that such specialized and directly dependent nodes may be not a suitable vehicle for a broader transfer of technologies and know-how. However, because the production of such intermediate inputs and tasks requires rather close integration into the international value chain and an already sophisticated technological and skill potential, these kinds of nodes are often located either in advanced regions or in emerging economies. Such high-level specification and specialization within producer-driven networks may impair the quality of the technology transfer. It may reduce the spill-over effects into the local economy and limit forward and backward linkages.

Furthermore, there is the threat that the foreign firm will move away once the local node reduces profitability compared to competing locations. The importance of the wages in and market potential of host regions is documented in Sleuwaegen and Pennings (2006). An example of such a threat is that a producer's network has a choice of different competing locations for a task. After a period of production in one country, a competing location in another country becomes more interesting and the task in one country is moved there. As a result, much of the technology transfer is reversed. Even more, the local firms which may have clustered around the foreign production unit are disconnected from the global chain indicating that large parts of the industrialization and modernization process were not sustainable.

2.2.5 Trade as a channel for technological change in developing economies

The above discussion has focused on FDI, with the implied technology transfer trade already an essential element of the argument. In fact, the mechanism described in the section above is only applicable if international trade is included. Being a node in a production network via FDI means that in order to produce, e.g., an intermediate product in this location, the node needs to import other tasks from the global network. After the intermediate good is produced, the node exports the intermediate good to the global network. Hence, international trade is an essential element in the FDI mechanism which is connected to the technology transfer (Saggi 2002).[14]

While within-firm trade is an activity governed by a MNE based in an advanced economy, in this section "trade" is used to describe trade between independent firms on the demand and supply sides via an international market.

Figure 14 shows that between 1960 and 2013, trade expanded more than GDP leading to an increase in the trade-to-GDP ratio over a long period. Hence, global interactions and interdependence has increased. These increasing interactions indicate both an increasing exchange of final goods and increasing activities within global value networks revealed by the increase in intermediate goods trade. Figure 15 depicts the increase in the total value of intermediate goods' trade which accompanies a rather stable share of intermediate imports in total imports.

The major mechanism that makes international trade a vehicle for transferring technologies and knowledge to developing countries is imitation (Saggi 2002).[15] When

[14] Liu et al. (2001) test for causality between imports, exports, and FDI in China. They identify a causal cycle running from imports to FDI, from FDI to exports, and in turn from exports to imports.

[15] Trade as a vehicle for technology transfer is widely discussed in trade based endogenous trade theory originating with Helpman (1992), Grossman and Helpman (1990, 1991), Rivera-Batiz and Romer (1991), and Young (1991), Gries and Wigger (1993), Gries and Jungblut (1997), Edwards (1998), Greenaway et al. (2002); for a survey on trade and technology transfer, see Saggi (2002).

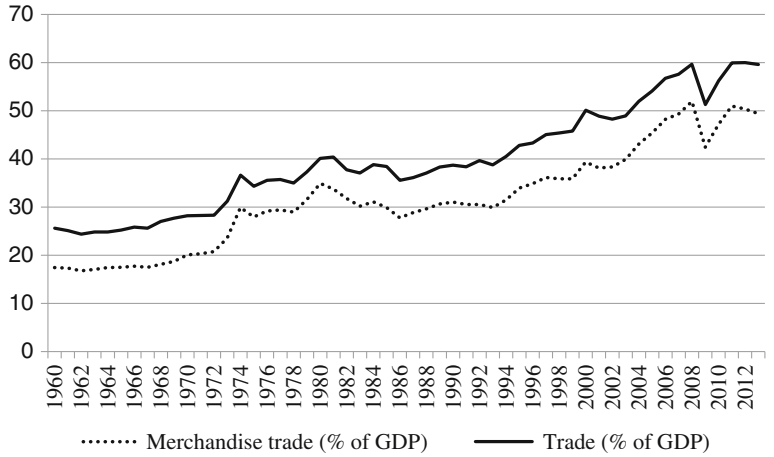

Fig. 14 World trade and merchandise trade as percent of world GDP, 1960-2013. World Bank (2014)

independent firms imitate international intermediates, final goods, intermediate goods or well-defined tasks are traded as components of an international value network. In this case, a connection to an international value chain and the respective requirements defined by said chain are again the key preconditions for a technology transfer through imitation.[16]

However, the international technology transfer is not automatic as in the FDI case although it may be more sustainable. An imitation process is challenging not only in terms of technological imitation, but also in terms of organizational and communicational abilities. Therefore, sufficient technological and engineering skills, sufficiently skilled labor and all other important determinants of a location are not the only factors at play for such a successful imitating firm (Benhabib and Spiegel 2005).[17] Most important or even a precondition is sufficient entrepreneurial capability.[18]

Entrepreneurial activity is crucial for discovering what a country is good at producing. Even though the social benefits of entrepreneurial activities may be strong, local conditions may lead to an undersupply of entrepreneurs (Hausmann and Rodrik 2003). However, local entrepreneurs are responsible for matching the output profile of their firms with the requirements defined by the international network. This forces them to adjust to changing technologies and organization conditions and leads to a technology and knowledge transfer by imitative learning. This is much more difficult and demanding than just being – via FDI – an outsourced node governed by a foreign head office. The connection to global markets is challenging for entrepreneurs in developing countries as they must have technical, business, organizational, and communicational capabilities and sufficient

[16] Connolly (2003) shows that high technology imports positively affect the imitation process, especially in developing countries. Parente and Prescott (1994) suggest that trade may affect the growth of a country by lowering the barriers to technology adoption.

[17] Vandenbussche et al. (2006) also highlight the importance of human capital in the imitation process and argue that imitation costs decline with increasing human capital.

[18] See Wennekers and Thurik (1999) and Carree and Thurik (2003) for the link between entrepreneurship and economic growth.

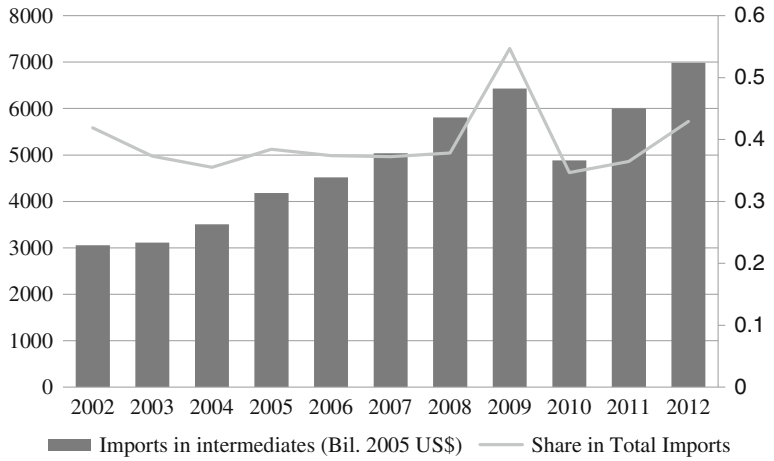

Fig. 15 Trade value of intermediate products and share of total trade. World Trade Organization (2013)

flexibility to be able to imitate and keep up with technical innovations. A lack of well-developed, targeted competences of this kind seems to be a limiting factor for well-functioning entrepreneurship. However, imitative learning improves the chances of a sustainable transfer of technology and knowledge to the local economy. The production technology is controlled and fully managed by local firms and local entrepreneurs. The imitated technology is now understood and controlled by local resources and hence available for further spill-over into the local economy. Acemoglu et al. (2006) show that an economy may switch from an imitation-based to an innovation-based strategy as it approaches the world technology frontier. As shown by Chu et al. (2014), it is optimal for economies at an early stage of development to implement weak intellectual property right protection in order to ease imitation. At a later stage stronger protection will be enforced in order to encourage domestic innovation. A switch from an imitation to an innovation strategy does not take place necessarily. Benhabib et al. (2014) show that economic agents growing through investments in innovation and imitation may optimally choose to fall-back to a productivity ratio below the frontier in order to take advantage of more efficient technology diffusion in the balanced growth path of imitators.[19]

However, the above discussion of technology diffusion and capability building assumes ideal conditions. Buyer-driven networks operate slightly differently. In a buyer-driven network, even if contracting firms are independent entities, the components and tasks are predetermined and clearly defined. Buyer-driven global value chains represent an internationally dispersed production system characterized by high competition and local ownership. Smaller firms in developing economies often produce homogenous goods for one large buyer. Market conditions thus resemble a monopsony. Goods produced by contracting firms in developing economies are technologically not highly sophisticated; their production process is neither horizontally nor vertically very deep compared to producer-driven chains. Profits are generated by the design and

[19] While some papers in this line of literature assume that innovation and imitation are performed by distinct firms, others assume that the two activities can be performed by the same firm.

marketing activities captured by developed-market retailers or branded manufacturers (Gereffi 1999). This has implications for market power and the distribution of potential rents. However, with regard to technological transfer contractors and sub-contractors do benefit through adjusting to the technologies and qualities introduced in such a value network.

Even if the governance structure is less predefined than for processes connected with FDI, the distribution of economic power in such networks is driven by the organizing nodes. Management nodes are close to the large markets in high-income economies. They possess detailed knowledge of how to successfully govern such a buyers' network (such as fashion labels) from a location in an advanced economy. Therefore, even if a connection to international markets exists and technology transfer occurs, participation is limited. However, the mere fact that there is production organized by local entrepreneurs and potential forward and backward linkages is a positive element of this phenomenon. Also, learning by imitation can be generated by this kind of connectivity. As elaborated by Schmitz (1989), entrepreneurs play an important role in driving growth through imitative activities. Local entrepreneurs may also become able to start their own buyer's networks for a domestic market. Furthermore, markets in other developing countries may become a target for entrepreneurs who have learned by imitation and who now can use the acquired know-how to open up a managerial node for a south-south network. South-south networks organizing south-south trade may mark another step towards more inclusive industrial development in more regions around the world.

2.3 Mechanisms behind asymmetric allocation of gains of technical transfer

Why do we observe large differences in the degree of participation in the gains from diffusing technological change? What mechanisms generate such large differences?

The above section describes the positive trajectory an economy may take if technology transfer is successful. As mentioned before, these elements of a positive trajectory were observable, but there is no country which followed this particular narrative in reality. We draw this picture because it can serve as a benchmark for identifying not only a potential consistent path of development driven by technological change, but also the obstacles along this path and the difficulties associated with inclusiveness. In the following we discuss three mechanisms behind limited participation in the gains from technology transfer and structural change for large shares of the population in developing economies. First, we discuss how FDI and firm-internal trade affect rent distribution (2.3.1). Second, we consider the role of independent trade processes and entrepreneurial activity (2.3.2). Finally, we discuss the role of local governments and institutions (2.3.3).

2.3.1 Rents, FDI, and firm internal trade

We start with the FDI and firm-internal trade links. These networks, no matter if they are producer-driven or buyer-driven, are dominated by foreign transnational firms. Nodes that organize international value networks are owned and located in the advanced world. They control the conditions of this connectivity and transfer of technology (Kaplinsky 2000). As power and control is clearly allocated between core and

peripheral nodes, rents can be easily distributed towards the owners and the controlling units of such networks. Local resources have no option but to accept these conditions, or leave the network.

As long as there is no market power on the side of the local resource and as long as there is an excess supply of low-skilled labor, wages are competed down. Even more, if there are potential rents due to the wages paid in the market and the wages that could be paid without a loss of competitiveness, this rent is distributed to the network owner. Why is there a rent? Technology transfer via FDI and firm internal trade can be illustrated by thinking of a production technology which has been in use in the advanced economy before. This production technology was originally capital-intensive when installed in the advanced economy. At the time of first implementation the technology embodied in the respective capital good was the newest technology and hence had a high price. The invested capital had a high value and hence was capital-intensive at the beginning of the capital good's life cycle. To give an example, a capital good has a value of ten units of currency and employs ten units of lower skilled labor when this technology vintage is installed. Skill-biased technological change leads to a depreciation of the installed capital vintage in the advanced economy at an assumed rate of ten percent a year. Hence, after some years this capital vintage is worth only half the original value. As a result, capital intensity has decreased through machine depreciation. An originally capital-intensive process has turned in a labor-intensive process as the same ten units of labor are now combined with half of the value of capital. With capital depreciation this machine vintage and its production process turns into a labor-intensive process. At some stage this capital vintage and the respective production process is economically fully depreciated under the wage-interest rate ratio in the advanced economy. A new capital vintage becomes more profitable and fully replaces the old vintage.

However, having fully depreciated the machine in the advanced economy with relatively high wages, the technology now has turned into a labor-intensive process. From the viewpoint of the owner in the advanced economy, this machine and its technology can now be transferred to a labor-abundant country. As in the advanced economy the switch point of full depreciation is determined by the wage rate in the advanced economy, the wage gap between advanced and labor abundant countries generates rents from this technology transfer. Let us assume that the machine vintage has been fully depreciated at a wage rate of ten units of international currency in the advanced economy. Then the firm knows that the same machine would still make a profit if the firm could find a location where the local wage rate is less than ten units in international currency. Thus a transfer of this old technology is profitable for the transnational firm if it can find a country where wages are less than ten units. Searching for such a location, the firm can easily identify labor-abundant developing economies in which wages are only one unit of international currency. Hence, there is a large wage gap – in this example less than ten, e.g. nine, to one - and the transfer of the technology leads to rents generated by this wage gap. The segmentation of global labor markets allows these rents to emerge. Allen (2012) illustrates the process of technology adoptions via vintage capital from industrialized countries and argues that this vintage capital is appropriate for developing countries when it meets their capital-labor ratio and their labor productivity conditions.

These rents are not a temporary phenomenon; rather, they may not disappear for a very long time. There are two reasons for a continuous existence of such rents.

(i) Unemployment due to Lewis labor pool conditions persists as long as the Lewis turning point is not reached. Even if an economy comes close to the Lewis turning point, the production process may be shifted to another country where the wage gap is still high. Furthermore, population growth is particular high in the poorest countries and hence will add additional labor to the Lewis labor pool. Thus, at a global scale there is no turning point in the foreseeable future.

(ii) To absorb labor via offering jobs in a modern sector, capital needs to be accumulated and machines need to physically exist and be installable. For a transnational firm, access to finance and hence the ability to finance such investments would not be a problem. However, a problem arises when looking at the physical capital, namely the machines. The installable machine is available as the result of a technological depreciation process. Existing machines have no or very low value as they were depreciated. As they were originally produced in an advanced economy, they are not reproducible for this value. These physical machines are of limited supply, as they are dismantled from the depreciated stock of machines in advanced economies. Hence, there is limited machine capital. This lack of low-price machine capital is at least partially due to a lack of an own machinery industry in developing countries. Not only that the elasticity of supply of physical machines from transnational firms is low. What is more, the technology is not adjusted to the skill and labor conditions in the developing countries.[20] In this vein Acemoglu and Zilbotti (1999) describe the mismatch between skills in developing countries and the transferred technology generated in and for the skill standard of industrialized countries, resulting in sizeable differences in total factor productivity. Basu and Weil (1998) argue that each technology is appropriate for only one capital-to-labor ratio. Only recently emerging countries like China or India are on their way to developing a significant own investment good sector which may be able to develop own technologies that are better adjusted to local conditions. Thus, neither the disappearance of the still growing Lewis labor pool at a global scale nor the supply of sufficient physical capital to absorb this labor pool can support the idea that the rents from global sourcing will disappear in the foreseeable future.

As the global value network is controlled by the head office in advanced economies, these rents can be completely distributed within the transnational firm. In the scenario of the classic capitalist firm, shareholders benefit most from these rents by far. Shareholders establish incentive systems which channel these rents to the capital owner, turning a potentially inclusive rent distribution into an exclusive one. It should also be emphasized that these are potentially pure rents and not factor rewards. So capital is already rewarded according to market returns including an adequate risk premium.

One prominent example of where value is added in a globalized production process and where it is captured is the distribution of value from innovation in the global supply chains of the Apple iPad and iPhone. Although assembled in China, Apple continues to capture the largest share of value from these innovations so the primary benefits go to the U.S. economy, since Apple maintains most of its high-wage functions like product

[20] An example is given by Lee and Wie (2015).

design, software development, product management, and marketing in the U.S. For example, an iPhone is sold in the US at a retail price of 600 US dollars. While the Chinese factory receives inputs worth around 188 US dollars, the factory gate price is a mere 195 US dollars. Taking distribution and other costs into account, Apple as the designer and marketer captures almost half the value added (OECD 2011b). Other examples of capturing value in value chains of electronic products (e.g., iPods and notebook computers) are presented in Dedrick et al. (2009) and Linden et al. (2009). Another striking example of rent distribution in global value chains is the production process of Barbie dolls presented by Tempest (1996). While assembly takes place in low-wage countries like Indonesia and Malaysia with intermediate products from Japan (nylon hair), Chinese Taipei (body material) and China (clothing) the activities with the highest economic value-added like design, quality tests and marketing take place at Mattel's headquarters in El Segundo, California, shifting most of the value-added to the United States. Similarly, internationalization and outsourcing activities can be observed in the apparel and footwear industries (e.g., Nike, Levi's, Hugo Boss) where the firm owns the brand, the products are designed and marketed at headquarters or value-generating nodes in industrialized countries, and the manufacturing process is outsourced to third parties producing in low-wage developing countries, turning these firms into "manufacturers without factories" (Gereffi and Frederick 2010). For example, Nike's footwear and apparel is manufactured outside the US by independent contract manufacturers that often operate multiple factories. The company is supplied by about 700 factories in 50 countries, largely Asia. Shoes that cost 16.75 US dollars to manufacture retail for around 100 US dollars in the US (Beder 2002).

By contrast, in a stakeholder firm all kind of groups including the local producing task may share the benefits. Local resources can be paid above local wages, they can enjoy better health and safety and/or be included in social security or health care programs which in fact some stakeholder firms have established.

2.3.2 Rents in independent trade processes

The second channel for a technology transfer from the advanced countries to backward economies is through pure trade. The entrepreneur is the most important link in the chain that connects the local, developing country or region with the advanced world. The entrepreneur is the key element from the perspective of the backward country, since only they can substitute for the function of the foreign firm. Their ability to imitate and transfer the imitated technologies to the local conditions and simultaneously maintain a connection to the international network determines the success of an independently acting local firm (Schmitz 1989). While in a first phase this imitation is likely to be related to a product that is more standardized and less complex with respect to the technology and production process, learning by producing may lead to a fast upgrade of the technology level, in particular when clusters of production can be formed. Imitation also includes imitation of organizational structures. Hence, when such local firms become more mature they can even expand towards establishing an own international network. This step often takes place in emerging market economies. They do not just emerge as markets with an increasing purchasing power –they are also characterized by the ability of an increasing number of firms to become globally active and imitate mature global firms that so far are mostly located in advanced economies.

With successful local entrepreneurs as elements in the international value network, developing countries become more likely to be included in the rent distribution within such a network. If these firms can be integrated in an international value chain, these entrepreneurs are in a similar position as described for the case of FDI. In this scenario, instead of transnational firms entrepreneurs and more highly educated labor (managers or engineers) manage the crucial technology transfer due to their ability to imitate the required technology and organize the connectivity. They make use of comparative advantages and combine their physical capital with low-wage local labor. Hence rents which were generated by global labor market segmentation and the large wage gap between advanced and developing economies can also be enjoyed by local entrepreneurs. We now observe that local entrepreneurs and highly educated labor are potentially able to participate in the rent distribution of international value networks. Hence, at least one group in a developing country, namely local entrepreneurs, can be included in the global rent distribution.

Participation in wealth and capital accumulation by local entrepreneurs through an increasing number of decentralized small and medium sized firms linked to the industry sector could allow for the establishment of a middle class. However, this depends on market conditions and the degree of competition for these goods from such developing-economy firms. Low profit margins in developing economies are caused by strong competition in buyer-driven value chains and could again redistribute rents to value networks controlled by firms in advanced economies. Competition is carried out by squeezing wages instead of increasing productivity (Giuliani et al. 2005).

Further, an increasing wage gap is a phenomenon not only in advanced economies but also in developing countries (Wood 1997; Verhoogen 2007; Feenstra and Hanson 1997; Hanson and Harrison 1999; Gindling and Robbins 2001; Attanasio et al. 2004; Marjit et al. 2004; Goldberg and Pavcnik 2004, 2007; Lee and Wie 2015; Zhang 2015). Hence, the increasing wage gap in successful middle income developing countries can be regarded as another consequence of skill-biased technological change that is now transferred to developing economies (Verhoogen 2007). The argument suggests that an increase in FDI (Feenstra and Hanson 1997; Lee and Wie 2015) and trade openness (Hanson and Harrison 1999; Goldberg and Pavcnik 2004) is linked to a rise in relative demand for skilled labor. The fact that transferred technological change is skill-biased leads to a compositional change in the products produced by developing countries, with the mix shifting towards more skilled labor-intensive products (Goldberg and Pavcnik 2004). Wage differentials for skills widen in line with trade liberalization. Trade policy-induced change in industry wage premiums may disproportionately affect workers at the lower end of the wage distribution, i.e., the more highly skilled workers gain relatively more. Incentives to export in developing countries generate differentials in quality upgrading: more productive plants increase exports, produce a greater share of higher-quality goods, and raise wages relative to initially less productive plants in the same industry (Verhoogen 2007). However, the skill premium alone cannot fully explain the increase in inequality in developing countries; other factors may also play a role, such as an increase in the size of the informal sector that is presumed to offer worse working conditions and lower wages and which is simultaneously expanding with a high-wage formal sector (Goldberg and Pavcnik 2004). As a further consequence, pure labor can only partially participate in benefits of technological diffusion due to the same arguments as discussed above with respect to rent distribution of

foreign firms. These rents are part of the observable increase in inequality we find in successful developing countries and emerging markets.

However, the discussed rents are likely to be a major incentive for local entrepreneurs to become active and they are a reward for making these technologies locally owned. With the imitation by a local firm the technology has completely arrived in the developing country. This is an important step as the technology is not just temporarily available, but rather a solid base for further development. An active local entrepreneur is the most limiting factor that is needed to develop a self-sustaining formal market economy. Locally appropriable rents may act as an incentive and reward for entrepreneurship. However, as long as entrepreneurs lack the relevant technological or managerial skills, sufficient infrastructure, or necessary institutional conditions, the locally appropriable rents are concentrated on a few successful entrepreneurs.

2.3.3 The role of local government in developing economies

As outlined in section 2.2, development of local entrepreneurship is important for technological upgrading of the globally linked market economy. Thus, in addition to large firms, small and medium size firms are important. Such decentralized firms can be the driving element of capital and wealth accumulation and lead to high employment. In order to allow entrepreneurs search for opportunities and realize new business ideas in new firms, or in order to expand existing firms, institutions for a functioning market system need to be created. When it comes to the distribution of rents that are created in this process, much depends on the good functioning of these institutions.

First, as it is likely that a local firm connected to an international value network can gain rents, firms in the formal sector may not only be taxed, they can also be regarded as an unconventional source of income for the government and public administration. If the administrative sector is low-paid and/or the culture does not proscribe bribery, bureaucrats may try to channel some of these rents to themselves (Robertson and Watson 2004). Indeed there is evidence that high levels of rents, e.g., occurring through natural or policy-induced sheltered industries, may promote corruption (Ades and Di Tella 1999). However, international openness and import competition, i.e., factors that may lower the level of rents, are associated with lower levels of corruption (Bonaglia et al. 2001; Treisman 2000). That this need not be a necessary consequence is shown in Gatti (1999) where the tariff structure is crucial for determining corruption outcomes of importing. Similarly, Lalountas et al. (2011) do not find positive effects of globalization on corruption for developing countries. Even if corruption is perceived correctly, firms believe in its arbitrary nature. That is, corruption hits everyone, even though not all firms are currently involved (Doh et al. 2003). If the corruption level becomes too high and impairs firm activity (Wei 2000), economic development is strongly damaged. Therefore, groups that have economic power, like entrepreneurs, the financial sector, or the government may benefit from those rents, while labor has potentially the weakest opportunities. However, it may be the case that bureaucrats absorb such a large share of the rents that the incentives for entrepreneurs disappear. As a result, corruptive behavior in public administrations may become a serious cause of low growth of markets and a serious obstacle for technology transfer to and rent distribution within such countries.

Figure 16 relates economic success measured in GDP per capita to the degree of corruption in a country measured by the corruption perception index (CPI). As a higher

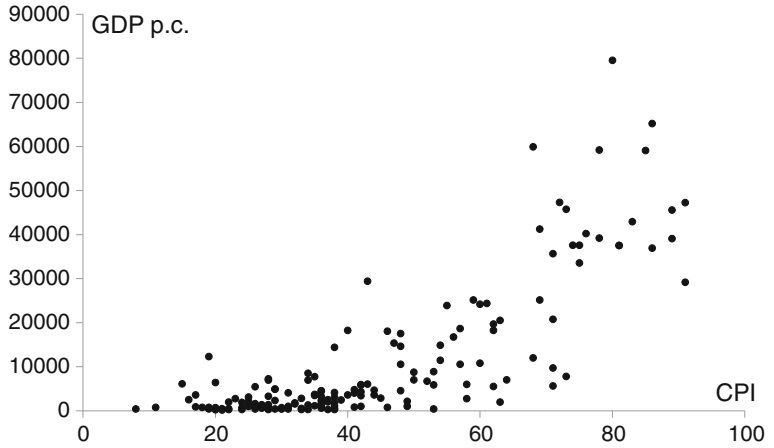

Fig. 16 Corruption Perception Index and GDP per capita (constant 2005 US dollars) for 160 countries in 2013. World Bank (2014); Transparency International (2014)

CPI indicates less corruption it becomes apparent that high-income economies perform better and have a lower level of corruption.

The second element directly related to government activities is the design of trade and internationalization policies. When designing trade policies governments have to balance two objectives. Conditions in the country must be attractive enough for foreign firms to invest, and the foreign firm should be encouraged by incentives or forced to transfer technology to local resources. A problem in this respect could be a race to the bottom in which countries try to attract foreign firms no matter the social costs. A negative example is discussed in Krautheim and Schmidt-Eisenlohr (2011) where tax competition is seen as such a race to the bottom. However, a positive experience that is even more directly related to technology transfer is that of China (Liu and Wang 2003). The Chinese government carefully designed policies that lead to joint ventures or firm cooperations that fostered technology transfer to Chinese resources (Ng and Tuan 2002). In the first phase of the Chinese opening-up policy, the spill-over effects were much weaker and the local economy could not grow as fast as in the second phase, which began in the 1990s when the Chinese turned their attention to such a technology transfer process (Long 2005). The Chinese case also shows that it is not a pure liberal trade policy that is most successful, but instead one which is directed towards a country's own interest in particular with respect to the transfer of know-how.

The third element that could be of major relevance and goes beyond the scope of local governments is a set of active international rules or institutions that counteract multinational corporations' attempts to implement "dirty" technologies in weakly regulated countries (Krautheim and Verdier 2016). International organizations can promote rules which can lead to more participation. One example is the enforcement of labor protection. These institutions, even if they may not have direct enforcement power, have the ability to enforce certain rules by making conditions public. In particular, labor and health conditions can be generally acceptable objectives. Furthermore, housing, drinking water or sanitary facilities or even hospitals for migrant or regular workers and their families could be in the focus of such rules. Seals of approval could assure quality management and be communicated to the public or the consumer.

The effectiveness of fair trade or eco-labels is for example documented in Loureiro and Lotade (2005) for the case of coffee. The kind of communication and disclosure of good or bad conditions is also a step towards greater market efficiency. For many consumers, "fair" and "non-exploitative" production processes can be an important characterizing element for a product. Therefore, if this information is not available, consumers cannot differentiate, so asymmetric information leads to market inefficiency. The potentially lack of disclosure by public institutions can in this respect be substituted for by NGOs.

3 Closing comments

This contribution links up to the article *Innovations, Growth and Participation in Advanced Economies - A Review of Major Concepts and Findings* (published in the previous issue of IEEP) in which the process of innovation as well as the effects of technological change on growth and distribution has already been discussed for advanced economies. In this article we focus on developing economies and highlight the process of technology transfer from developed countries to less developed countries. The transfer of technologies is a substantial feature of globalization of trade and investment. This happens mostly through either a direct transfer via FDI and trade, or through imitation done by domestic firms and entrepreneurs amplified by international trade relations. The corresponding structural transformation and modernization process allows for a diffusion of technology and helps to make transferable technology broadly available and controllable in the local developing economy. Technological innovation and globalization is, however, not fully inclusive in developing countries. To a large extend technology transfer is organized through global value chain networks. Transferring a technology to a developing country may be a particular profitable investment at lower wage rates. With a large wage gap between advanced and developing economies internationalization of production and the transfer of technology via global value networks not only generates efficiency gains, but also rents. So the distribution of these rents determines, how inclusive this transfer of technology is. Investigating global participation and inequality we see that total disparity measured by a global Gini coefficient has not changed dramatically. Further, looking at more details we can see that upper middle and high income groups in emerging markets and middle income developing economies could gain from innovation and technological change, while middle income groups in advanced economies however, could only weakly gain or were not included in the distribution of benefits from the process of technological change and overall income growth even if most technological innovations were generated in the home countries of these groups.

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