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Does technological change drive inclusive industrialization? A review of major concepts and findings

T. Gries, R. Grundmann, I. Palnau and M. Redlin

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Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: http://mgsog.merit.unu.edu

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

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Does Technological Change Drive Inclusive Industrialization? - A Review of Major Concepts and Findings

T. Gries, R. Grundmann, I. Palnau and M. Redlin

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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 social benefits for societies. Whether in reality opportunities from the process of technical change turn into real and inclusive benefits for a society depends on a number of facts. Hence, in this contribution we focus on the question of inclusiveness for the global process of innovation and technical change. We discuss a number of questions such as: Does technical change in DCs show specific characteristics that affect different groups of labor asymmetrically? Further, for the transfer of technologies to LDCs we ask: What are the channels of technological transfer from DCs to LDCs that allow developing economies to participate in benefits of technical change? How can a transfer of technologies affect economic and social development? After identifying such elements that link technical change to the question of inclusiveness we describe the effects of technical change on inclusiveness in DCs and LDCs. We try to answer questions like: Which groups benefit more or less from gains of technical change? Were benefits inclusive for a major share of the population or could basically small groups take advantage? Which are the reasons that led to non-inclusive growth for a larger share of the population.

Key words: technological change, global technological transfer, structural transformation, development, inclusiveness

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Corresponding author:
Professor Dr. Thomas Gries
University of Paderborn
International Growth and Business Cycle Theory
Warburger Strasse 100
33098 Paderborn, Germany
e-mail: thomas.gries@notes.upb.de
phone direct: ++49 (0) 5251 60 2113
phone secretary: ++49 (0) 5251 60 2114
fax: ++49 (0) 5251 60 3540
homepage: Center for International Economics (CIE)
http://www.C-I-E.org

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'The Role of Technology and Innovation in Achieving Inclusive and Sustainable Industrial Development'

1. Introduction

Technological change is one, if not the most important, engine for economic progress and structural transformation which is sometimes regarded as an important element for moving towards a prosperous economy. Technological innovations could be a powerful process that opens-up opportunities to increase social welfare and deliver social benefits for societies.

Is technological change socially inclusive? Do these opportunities of technological change lead to benefits for the society and are all included in gaining benefits? Do societies of the advanced economies which generate global technological progress gain in an inclusive way? Is the transmission of technological change to lower income economies beneficial for these societies, and do the people in these countries broadly benefit? Is technological change socially inclusive from a global perspective?

Whether opportunities from technological change turn into real and inclusive benefits for a society depends on a number of conditions. The belief that technological progress will induce 'Pareto improvements' in the allocation of resources and hence is always beneficial is only true in a hypothetical "first best" world where only efficiency matters. As we know from welfare economics there is however a difference between "efficient" and "optimal". Apart from efficiency a society can evaluate economic conditions and regard them as acceptable or not. The notion of social evaluations of a distributional outcome goes beyond the criteria of pure efficiency, even if efficiency is important. Hence, as long as societies care about the distribution of income, inclusiveness will matter.

Hence, in what follows we focus on the question of inclusiveness for the global process of innovation and technological change. After giving a conceptual overview in section 2, in section 3 we discuss the major elements and characteristics of technological change in advanced economies and the mechanisms of diffusion and transfer of technological change from advanced to less developed economies. Here we also consider specific characteristics of technological change in advanced economies that particularly affect inclusiveness. We discuss a number of questions such as: Does technological change in advanced economies show specific characteristics that affect different groups of labor asymmetrically? Can we explain such asymmetries? Do new technologies affect the structure of the firm? Further, for the transfer of technologies to less advanced economies we ask: what are the channels of technological transfer from advanced economies to less developed economies that allow developing economies to participate in merits of technological change? How can a transfer of technologies affect economic and social development?

After identifying such elements that link technological change to the question of inclusiveness we describe the effects of technological change on inclusiveness in advanced economies and developing economies in sections 4 and 5. We try to answer the questions like: Which groups benefit more or less from technological change? What conditions would result in non-inclusive growth and structural transformation? We try to answer these questions first for advanced economies (section 4) and thereafter for developing economies (section 5). In section 6 we finally look at the world as an integrated entity and discuss the conditions for technological innovation to foster more inclusive global development. In section 7 we discuss policy

implication and suggest some policies that promote a global inclusive technological transfer, and in section 8 we summarize our findings and conclude.

2. A conceptual framework of technology, structural change and social inclusiveness

In this section we introduce the conceptual framework. Major terms and notions which will be consistently used throughout the discussion are explained in more detail when they are introduced first time. However, three central notions are in the narrow focus of this contribution and should be defined explicitly at the very beginning.

Technical progress and innovation is defined as a change in technology that leads to a higher value of output given a set of input quantities. Thus technical progress can be either due to process innovation or product innovation. In case of process innovation a given product with a given value can be produced with less resource. In case of product innovation, a product with improved characteristics is invented and hence the willingness to pay (the value) of the product increases while pure production can be done with identical resources

Development and structural transformation is the sectorial change from an economy which is characterized by large shares of agriculture production towards an economy in which the industrial and service sector with sophisticated services becomes the dominating sector. Naturally, this structural transformation goes along with a change from a rural to an urban shaped society.

Inclusiveness or *social inclusive process* means that a major share or even all members of the population of a society are affected by a process.

With these three central notions and definitions in mind we may start with some fundamental theoretical considerations.

2.1 The social welfare function: Technology as two-edged sword

On a political level, a substantial discussion has taken place over the past three decades on the need to raise the 'competitiveness' or more accurately 'efficiency' of national economies.[1] Guided by economists who were arguing from an apparently very convincing narrative of a (hypothetical) perfect market economy, policy makers tried to transfer from this hypothetical model policies for improving the efficiency of their economies. These policies were crafted and implemented under the influence of the First Welfare Theorem which states that under well-defined conditions *"*A competitive market equilibrium is an efficient allocation*"*. Especially since the late 1970s and starting with Reaganomics in the USA and Margaret Thatcher in the UK the deregulation of markets and trade dominated policy approaches. This however, not only happened in major Western economies but also in many developing countries through the policy advice and influence of the World Bank and IMF.

[1] The term 'efficiency' is used in the classical way. A state is more efficient, if for the same outcome less resources are needed, or with the same quantity of resources more value of output can be generated.

However, in this enthusiasm for efficiency politicians and even worse economists seem to have forgotten about the Second Welfare Theorem that states "Any efficient allocation can be realized as a competitive market equilibrium given an appropriate set of lump-sum taxes and transfers (transactions without incentive distortion)". The Second Welfare Theorem affirms that there may exist a potentially infinite number of efficient (and market) outcomes that may be consistent with a society's requirements for the distribution of incomes and wealth, even in a hypothetical first-best world.

Furthermore, as the world is in fact rather a "*second best world*"[2] than a "*first best world*", and societies do evaluate and judge the distribution of incomes and wealth, such that there is notion of what is an 'unjust' distribution, *technological progress* can become a vehicle for *the better and the worse*. Technological innovation is therefore a two-edged sword.

This can be illustrated using social welfare functions. Figure 2.1a depicts a production possibility frontier (PPF_i) for an economy and the set of social indifference curves W_i belonging to the social welfare function W.[3] The original allocation is point A which indicates that the economy is not on the production possibility frontier ($PPF_{t=1}$), and that the allocation of resources is hence inefficient. An efficient allocation is at point B.

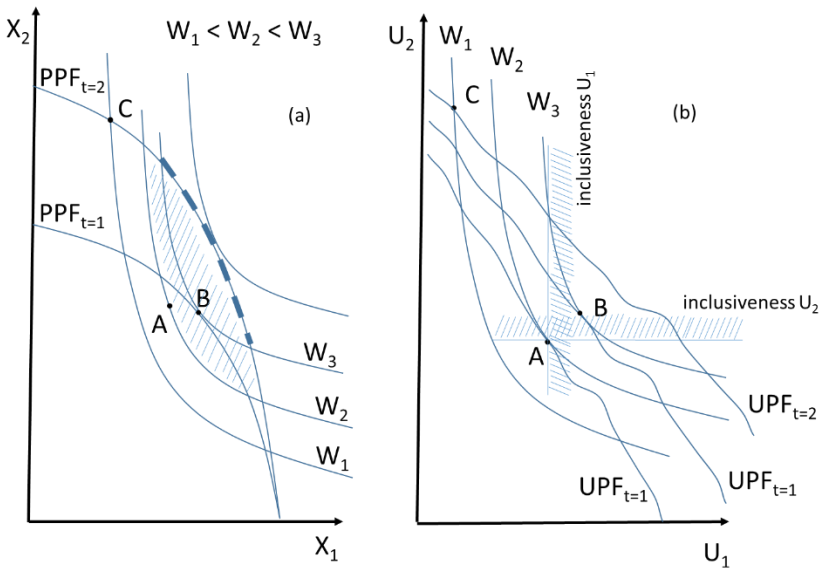


Figure 2.1: Example for negative welfare effect of technological change under second best conditions

[2] The notion of first and second best economic states refers to the fundamental question how an economy can be organized to become efficient. An economy is in a first best state, if all conditions for efficiency are simultaneously satisfied. This is the theoretical ideal state of an economy. However, it is an unrealistic benchmark. Therefore, the notion of 'second best' is introduced. If one or more efficiency conditions cannot be satisfied because of e.g. rigidities, information problems, imperfect markets, missing markets etc. a first best solution cannot be obtained anymore. However, an economy can try to come as close as possible to an efficient outcome. Solving this problem is called second best economics. Trying to find the next best solution, if first best cannot be obtained, is the second best solution.

[3] Production possibility frontier (PPF) describes all combination of goods that an economy can at most process. Social welfare function is a theoretical concept that portrays the preferences of a society and describes under which conditions a society is better or worse off.

With technological innovation the economy obtains more production possibilities and the production possibility frontier moves outward. The production possibility frontier expands at $t=2$, PPF_2. With the new technology the economy can produce more of both goods. However, in this imperfect and hence "second best world" the new consumption point associated with the new technology is point C. Even if the economy is technologically more advanced, and produces technologically efficient on PPF_2, point C represents a lower level of social welfare, $W_1 < W_2$. A welfare improvement through technological change could have been reached if the economy had realized a point somewhere in the shaded area. Hence, moving from A to C as the result of technological change was not beneficial in this "second best" example. We could move away from the allocation of goods and construct such an outcome in terms of social evaluations of distributions in the utility space.

In figure 2.1b we draw the utility possibility frontier (UPF_i) for two individuals in this economy. The $UPF_{t=1}$ depicts the utility individual 2 may reach given the utility of individual 1. In the utility space A is neither an efficient allocation, nor optimal according to the preferences of society. An efficient and optimal allocation would be B in Figure 2a and 2b. Further, technological change expands the UPF_i towards the new frontier $UPF_{t=2}$. Hence, on the one hand technological change could be beneficial and inclusive for both individuals leading to a higher welfare in B. On the other hand technological change could be biased leading to outcome C. Outcome C is not optimal even if outcome C indicates an efficient product and resource allocation. However, non-symmetric benefits of technological change were not inclusive for individual 1 and hence the distribution changed significantly and hence led to a welfare loss. With respect to welfare C is still inefficient.

The shaded area in figure 2.1b describes the inclusive changes in utilities for each of the two individuals. As the social welfare function W evaluates distributions the society will realize a welfare loss as the result of such biased technological change.

2.2 Conceptual approach

The example above in figure 2.1 illustrates that under second best conditions it depends on society's decisions and regulations to direct the technological progress or its benefits towards processes that include a sufficiently large number of people leading to an inclusive growth, or to let the benefits enjoy only small groups leading to more inequality and income disparity. Hence, if societies have any idea of what is an unjust income distribution, inclusiveness matters. Therefore, a discussion of technological change cannot be reduced to the issue that technological progress and innovation is the major source of income growth and structural change. It is important to ask who is able to benefit from this technological-induced process of structural change.

There are two major dimensions that have to be discussed to broadly understand the importance and the effects of technological change on world growth and development, structural transformation and the question of inclusiveness.

First, technological change that originated in the *advanced economies* is the driving source of per capita income growth. At the same time technological change is *skill biased* and hence

affects social inclusiveness at the same time as driving the growth process. Low, middle and high skilled labor are asymmetrically affected by technological change.

Second, the transfer of technologies to developing countries via direct transfer or imitation is a substantial feature of the globalization of trade and investment. Hence, technological change affects all countries that introduce technologies new to their domestic production.

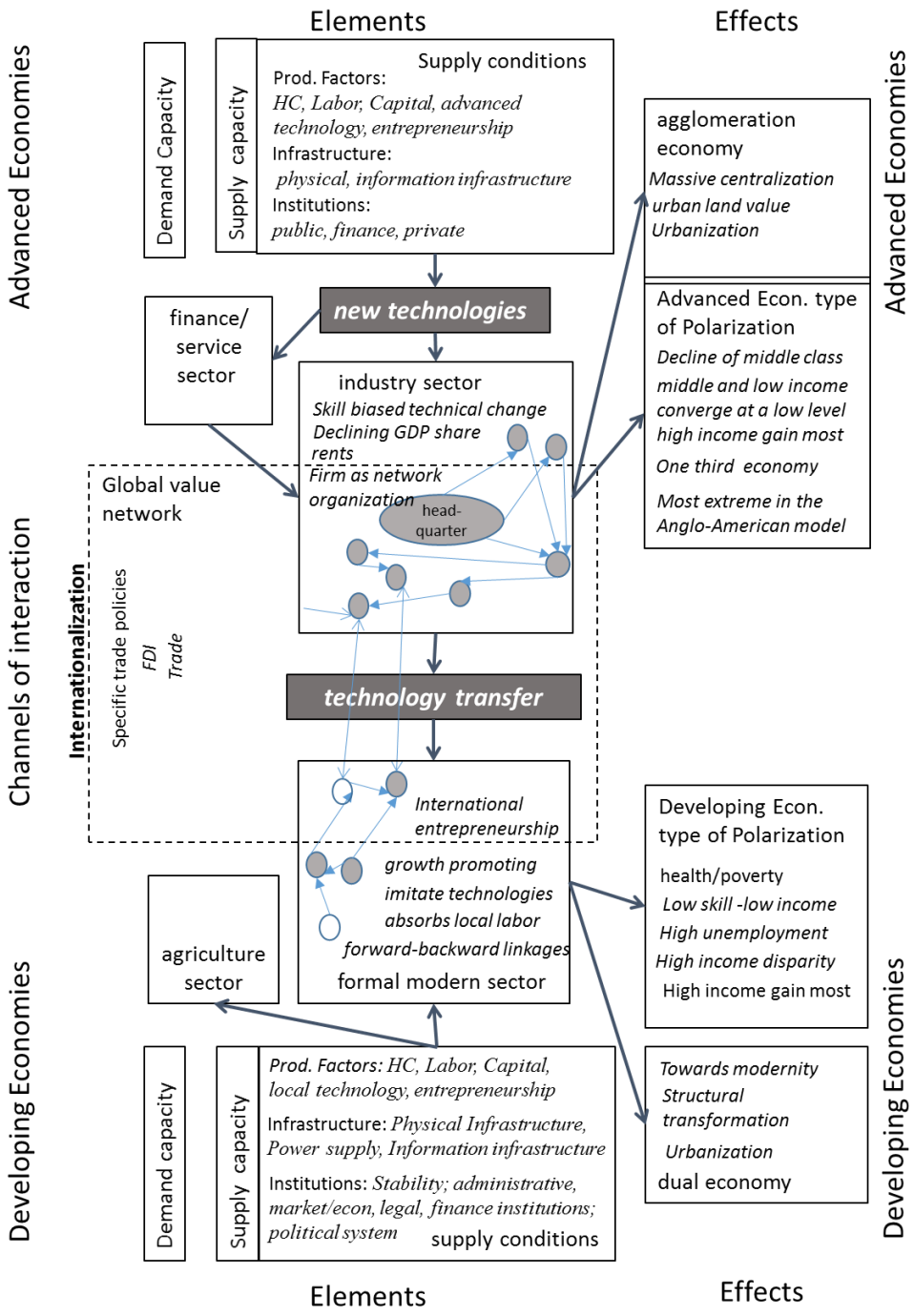


Figure 2.2: Conceptual framework and overview

The spread of technologies used in manufacturing and other economic sectors from advanced to developing economies has been accelerated as a result of political decisions which since the

1970s drove the latest phase in the globalization of the world economy (Gries, 2007). More than two billion people entered world markets or tried to be closer integrated, most prominent China (since 1978) and the countries of the former Soviet Union (since the 1990s). Also other large emerging economies such as India turned towards a more open and internationally integrated economy from the early 1990s. Hence, for a significant share of world population chances of being included in the potential benefits of innovations and technological change substantially increased over the past four decades.

The conceptual line of discussion in which these two dimensions, technological innovation and technological transfer, are embedded is visualized in figure 2.2. The upper part of the figure describes elements and effects in the *advanced economies* that are related to technological change and inclusiveness.

With reference to '*elements'* we consider supply side conditions, the industry sector as well as firm-level conditions. Under *effects* we discuss two boxes which list the effects of technological change in advanced economies. One box points towards an economy in which agglomerating centers gain importance to host a modern service and central elements of the industry sector. The second box points towards the income effects of this asymmetric technological change with respect to inclusiveness.

The center of figure 2.2 describes the channels of technology diffusion and transfer from advanced economies to developing countries and emerging markets via global value chains, FDIs, and trade and imitation.

The lower part of figure 2.2 describes the elements and effects of technology transfer with respect to the question of inclusiveness for developing economies. As *elements* we consider the supply side conditions which allow for a technology transfer, and modern formal and often industry sector development with forward and backward linkages which absorbs labor with low productivity during the structural transformation process. As *effects* of modern sector development there are two boxes which describe the effects of transfer of technological change from advanced economies to developing economies. One box notes economic polarization, or dual economy, where the modern sector expands much faster than the traditional primary sector. The second box points summarizes the income effects of this asymmetric sector developments with respect to social inclusiveness.

In these following sub-sections we discuss the two components of this conceptual framework.

2.3 Technological innovation in advanced economies

Advanced economies generate almost all new technologies. While the magnitude and direction of technological change still does not seem to be fully understood it is proposed that level and direction of technological change are somehow endogenous and driven by incentives, including the size of the market.[4] The objective of firms to reduce labor cost and a feasible technology to substitute low and medium skills by sufficiently cheap new technologies is responsible for skill biased technological change in advance economies.

[4] The question whether aggregate technical change can be determined by incentives and decisions is discussed broadly in the endogenous growth theory which we will consider in more detail below.

Over the past three decades this skill biased technological change (SBTC) together with a routine biased technological change (RBTC) have been a major cause of asymmetric development of jobs and income in advanced economies.[5] More precise, we can observe a polarization of job growth towards low and high income jobs and a shrinking of the middle class in recent years. Job growth in advanced economies was largely restricted to low wage jobs in the services sectors since the early 2000s.

Furthermore, accompanying SBTC and job market polarization we can also observe a polarization of income levels. The income ratio for the highest 10th percentile to lowest 10th percentile of the income clearly increased. Job and income polarization was most apparent in the Anglo-Saxon countries. Thus at least since the 2000s substantial proportions of the labor force of advanced economies were excluded from the benefits of technological change. The current ongoing trends in innovation that is determining the nature of production, manufacturing and tradable services, analyzed under labels like "advanced production", "industry 4.0", or the "industrial internet" is posing significant challenges for social inclusiveness.

It was not only skill and routine biased technological change that contributed to the observable rise in inequality in the advanced economies. New technologies, in particular information technologies, also changed the structure of the firm and through this the extent to which different types of labor share the results of higher productivity.

Specifically, new technologies facilitated on a firm-level a separation of tasks. This meant that in an industry sector firms have become networks of producing nodes. These node can be located within an individual firm or outside of the firm, and they can even be located internationally. Hence, the globalization of tasks according to comparative advantage contributes to the growing wage inequality and job market polarization described above. Indeed, labor intensive tasks and intermediate products can be more easily allocated to labor abundant countries with relatively low wages. Hence, locations for tasks which are so far placed in advanced economies, now directly compete with locations in labor abundant developing countries.

As described by the Stolper-Samuelson-effect and the Factor Price Equalization Theorem,[6] globalization of the value chain is an additional factor accounting for the loss of jobs in advanced economies where low and medium skills are required, hence also reducing wages of these categories of workers. Through trade labor market segments are linked together, and thus according to the factor price equalization theorem labor groups in advanced economies implicitly compete with similar skill groups in developing countries and emerging markets. Hence, wages of these skill groups tend to converge resulting in pressure on these groups in advanced economies.

In spite of the above theoretical mechanisms, a number of studies claim that skill biased technological change is more important than the globalization of production. May be these jobs

[5] SBTC and RBTC focus on the idea that particular low skills and routine tasks can be replaced by the introduction of new technologies.

[6] The Factor price equalization theorem states international factor prices will converge through trade. However, only with identical technologies there may be full convergence.

are lost due to the technological change before the transferred technology is introduced and combined with low wage labor in developing economies. *'The deteriorating labor market outcomes of less-educated workers in most OECD economies over the past two decades despite their increasing relative scarcity strongly implies a strong decline in the relative demand for less-skilled workers. Skill-biased (or unskilled labor saving) technological change and increased exposure to international competition from less developed countries (Stolper-Samuelson effects) have been offered as the leading candidate explanations for this demand shift.'* (Katz and Autor, 1999: 1530)

Another explanation for job market polarization suggests a dominance of capital accumulation and a secular increases in the capital to income ratio as major source of increasing inequality (Piketty, 2014). However, according to basic growth theory[7] a continuous change in the share of capital income in total income depends on the elasticity of substitution and on the fact that the economy has not yet reached a stationary state position. It is hard to believe that there are simple universal laws (Piketty, 2014: 52, 166) behind the rise of inequality in factor income during the recent two decades. However, there are observable facts about these development of rising inequality which we should try to understand much better than before.

One of these facts is a long term increase in the wealth to income ratio in advanced economies since World War II. This is particular striking in countries that had a strong increase in housing and real-estate prices. This observation raises the relevance of the theory of regional agglomeration and endogenous regional and urban development. As a result the local immobile factor, urban developed land, is the factor that eventually benefits most from any productivity growth in the urban area. Thus, urbanization and agglomeration and the resulting growth in demand for urban developed land is another cause for a non-inclusive income and wealth growth accompanying structural transformation. Since the mid-1980s in particular, we observe a continuous increase in the ratio of land and housing prices compared to general producer prices, not only in advanced economies but also in some emerging economies, including Brazil, China, India and South Africa amongst others. This process simply indicates that a significant share of total wealth is earning high profits and growing faster in value than GDP and hence favors a rather small group of land owners.

2.4 Transfer of technology to developing countries

The *transfer of technolog*ies *to developing countries* via direct transfer and imitation is the second dimension to be discussed in relation to the conceptual framework in figure 2.2.

Technological change, growth and inclusiveness is directly related to technology transfer from advanced to developing countries. Firms, as globally producing networks, are major agents in this transfer process. Linking up to their (global) value chain networks is an important condition for imitation and adaptation for firms in developing countries. Technological change in developing countries happens mostly through either a direct transfer via FDI and trade, or through imitation catalyzed by the use of trade relations. However, to encourage firms to engage in outward foreign investment, or include a location in a developing country into its production and value chain network, requires certain domestic conditions to be met. Similarly, domestic

[7] Neoclassical growth theory as Solow (1956).

entrepreneurs can only be inspired to search for opportunities by imitating international technologies and link up to global markets if the business environment in the domestic developing economy is sufficiently encouraging. Among others, such conditions include appropriate human capital, infrastructure, institutional frameworks like protection of property rights, low levels of corruption and political and macro-economic stability.

As far as technology transfer by international integration is concerned not all trade is equally beneficial. Manufacturing trade is seen to be most beneficial. Manufacturing trade promotes modernization and the modern sector is the key sector for a sustainable structural transformation towards industrial production and sophisticated services as well as general development. The modern sector allows diffusion of technology most directly and helps to make transferable technology broadly available and controllable in the local developing economy. Backward and forward linkages as well as spill-over effects promote regional and country development such that the modern sector is crucial for overall development of a country. Feedback loops to an accumulation of human capital and improvements of institutions can be also expected.

In principle the 'modern' sector has no limits with respect to inclusiveness. Even if the value in agriculture production may grow this sector can only absorb a limited number of owners and workers due to land being restricted. Hence, inclusiveness is ultimately limited. This is different for the modern sector. The modern sector can potentially accommodate an unlimited number of people. However, there is an important constraint for a low income country: as long as it is not sufficiently integrated into international markets, there will be an insufficient demand for industrial goods and intermediate inputs. Therefore, modern sector development requires international integration. Linking to global markets can reduce lack of demand that may hold up industrialization and acquisition of technology. These two elements of the international linkage are the most crucial.

However, a complementary factor that is a necessary condition for the development of a formal domestic modern sector, and for linking up with global value chains, is entrepreneurship. Entrepreneurs are key agents in any market-based development: Entrepreneurs search for opportunities, realize their business ideas and by doing so develop a formal economy. Entrepreneurs are the protagonists who can organize the technology transfer towards the domestic economy and potentially promote growth. Therefore, the modern sector with potentially unlimited opportunities for entrepreneurs is central for participating in the technological change generated in advanced countries and for obtaining inclusiveness for developing countries.

Even if technology transfer to developing countries is a great opportunity for turning on a path of self-sustained structural transformation, conditions within a country can result in participation in global technology on the one hand but at the same time exclude large numbers of people or groups within a country. For one, it is more likely that high skilled labor and entrepreneurs will more proportionately benefit from globalization and technological upgrading. However, low and middle skills are only partially included. With technology transfer from advanced economies will have elements of a skill-biased technological change. As in advanced economies we observe high unemployment even for labor with primary or first years of secondary education, with labor market conditions often resembling the 'Lewis Labor

Pool'. Hence, there is high competition for a still limited number of jobs in the modern formal sector. As result wages will be driven down. However, even if hourly wages are likely to stay rather low family income may increase via a higher labor market participation of family members. Thus, some kind a low level inclusiveness is implied even in this scenario.

Technological innovation and globalization however are not fully inclusive in developing countries. To a large extend technology transfer is organized through global value chain networks. These global value chains come about because they lead to both a higher efficiency and additional rents. For instance if in advanced economies a certain vintage of machine is depreciated and a newer vintage machine can substitute for the old vintage at lower costs, this machine may be still profitable at the lower wage conditions of developing economies. Hence, transferring the technology to a developing country may be a profitable investment at lower wage rates. In developing countries market wage however is often much lower than required for making such an investment profitable. Hence, this wage gap generates a rent which is a result of globalization. How inclusive globalization is in this respect depends on the distribution of these rents. In case of typical multinational enterprises (MNE) these rents are channeled to management and shareholders. For a stakeholder firm, which may also ascribe to notions of Corporate Social Responsibility (CSR), more stakeholders may be included in rent distribution, including local or indigenous labor. In this case the mode of inclusiveness may emphasize work safety, better sanitary conditions or housing for employees, and other social benefits. If the link to the global value chain is organized by local entrepreneurs, these entrepreneurs may also participate in such rent distribution.

However, there are more agents apart from enterprises who can channel rents into their own direction. An important agent is the government. Through corruption politicians and bureaucrats can participate in rent distribution. As long as this does not reduce the activities of multinational enterprises or local entrepreneurs significantly this remains a rent redistribution. If corruption becomes too extensive and firms reduce their activities, the struggle for rents will have a negative aggregate impact.

Through its trade policy a government will also influence technology transfer and rent distribution. An example is China's trade policy. Chinese policy was aimed at encouraging international investors to transfer as much know-how as possible to local agents. Multinational enterprises were obligated to let local firms participate, both in technology and rents. Another channel is enforcement of rules in favor of working conditions – e.g. minimum labour standards. Employment rules for local labor including work safety standards and others, could be introduced. For this kind of trade (and labor market) policies a trade-off may exist between restrictions on international investors which might discourage them to invest, and the important transfer of know-how which is crucial for the local economy to develop. Hence, competition of countries for attracting important international investor can lead to a 'race to the bottom' for labor safety regulations, environmental rules or taxation. Hence, international institutions might establish such standards and internationally coordinating mechanisms to prevent such race to the bottom.

If international institutions are blocked because governments cannot agree on rules or because interest groups have captured these institutions NGOs may be able to step in. In many respects

NGOs can substitute for missing governmental institutions and rules. The fact that consumers do not buy a homogenous good but a vector of characteristics of a good can help in this respect. The product characteristics such as non-exploitative production conditions, or no child labor can become important elements of decision making for consumers. With coordinated quality labels consumers can reveal preference for respective production processes. Hence, information about these processes are important and such information combined with consumer decisions could substitute for governmental enforcement.

Moving from the perspective of the country level to a discussion of inclusiveness from a global perspective three major phenomena can be observed. First, total disparity measured by a global Gini coefficient has not changed dramatically. A similar finding can be stated for the Lorenz curve.

Looking at two ends of the income distribution we observe that the highest income percentiles of the world income distribution gained substantially from the process of technological change and global growth and hence were strongly included in benefits. Simultaneously the five lowest income percentiles of the world could not benefit. As a result the disparity between the extremes in income distribution increased further.

Second 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. These group were strongly included in the generated benefits. Middle income groups in advanced economies however, could only weakly gain or not be included in 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.

After this general overview and description of the conceptual framework we can turn to a more detailed discussion in the next sections. In the following section we discuss the major elements related to technological change and the issue of inclusiveness

3 Elements of technological change and international technology transfer

In this section we critically discuss three elements of technological change and the diffusion from advanced economies to developing economies. The three elements that characterize this process are *biased technological change* in advanced economies, the technologically driven changes in the structure of the firm and *the firm as global value network* and within a globalized production the *technologies transfer by FDI and trade* towards developing economies.

3.1 Skill-biased technological change in advanced economies

What is driving technological change in advanced economies? What is the effect of technological change? Is technological change directed towards a specific factor of production? Is technological change beneficial for a sufficiently large number of people to be inclusive?

By far most of all technological innovations are generated in the todays advanced economies. Figure 3.1 shows the global distribution of triadic patents to indicate the origins of new technologies. According to this measure more than three quarter of global innovations are generated in advanced economies. Thus, global technological change is dominated (almost by definition) by the advanced economies.

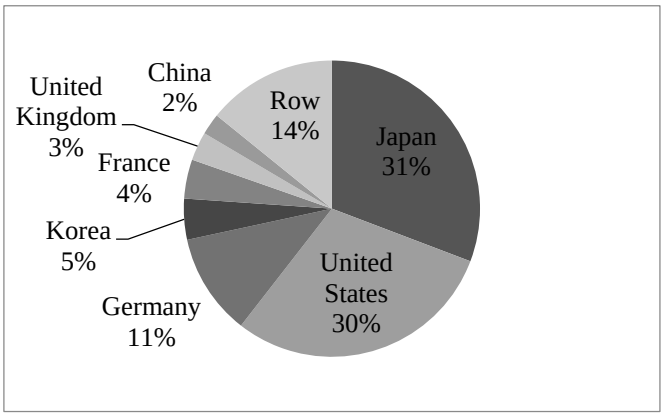


Figure 3.1: Global distribution of triadic patents[8]

What generates technological change? A large literature, spanning more than a decade has tried to explain the determinants of technological change. While this debate helped to understand how to promote technological innovation, it is still not conclusive if the rate of progress indeed is an endogenous choice. In other words, even if we have a better idea of what drives technological growth we still do not understand fully why technological abilities show for mature economies in steady state a secular continuous annual growth rate of about two percent.[9]

[8] OECD Patent Database 2015.

[9] Endogenous growth theory tried for a decade to make technological change an endogenous choice. This discussion includes seminal contributions like Romer (1986), (1990), Lucas (1988), Barro (1991), Grossman and Helpman (1991), Aghion and Howitt (1992), Mankiw (1995), Barro and Sala-I-Martin (1995), and abated with contribution by Mankiw, Romer and Weil (1992), or later moving to semi-endogenous mechanisms as by Jones (1995) or Young (1998). An overview of various mechanics, shortcomings and problems is given by Aghion and Howitt (1998) or Jones (1999).

Figure 3.2 depicts changes in labor productivity. In advanced economies this may indicate a technological change in favor of labor productivity. While there seem still differentials in the level of the growth path, the development is continuous and rather parallel for these countries. Taking the G7 average annual growth rate of labor productivity was about two per cent during the last three decades.

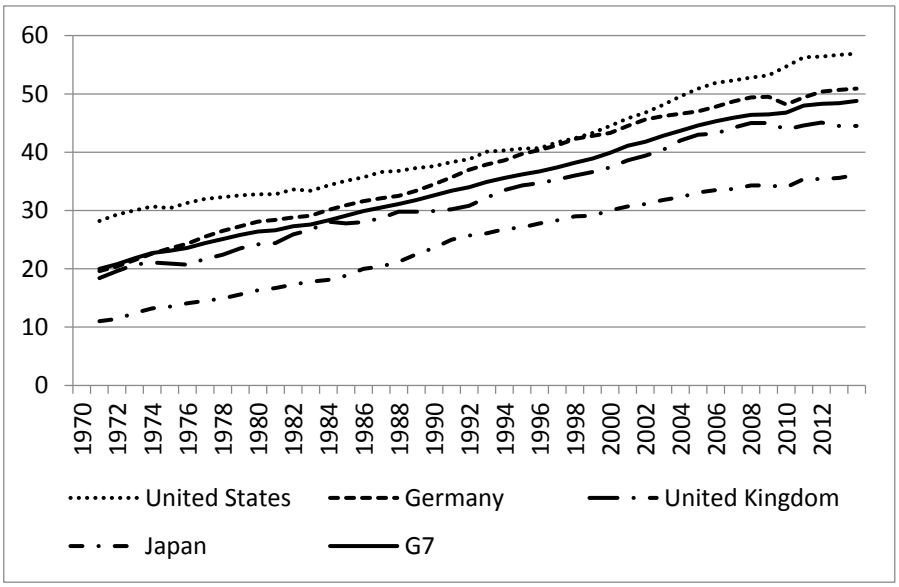


Figure 3.2: Technological progress measured as labor productivity per hour worked, selected advanced economies 1970-2013 (USD, constant prices, 2005 PPPs)[10]

However, even if the level of technological growth remains puzzling it seems that the direction of technological change is endogenous. In general technological change is the result of a number of components, including the creativity of inventors, costs of capital good in which the new technologies is embodied; and the demand for the invented capital good which is determined by incentives to implement the new technologies.

All these components make the implementation and direction of search for innovations endogenous (Acemoglu, 1998; 2002; 2007). Introducing a new technology implies that there is a demand for a novel technology while the supply is at reasonable costs. The investment needs to be beneficial, that is, either the innovation must not be too costly, or the effects are sufficiently large. Hence, technological progress is endogenously driven by market conditions like supply and demand, and technological conditions in terms of simplicity and costs efficiency of introducing the new technology (Jones, 2005). This becomes particularly clear when technological change can substitute for an important factor of production like labor. Looking at firm level technological progress it is an implementation of new technologies driven by economic incentives.[11] When firms are facing high labor costs and an opportunity to implement

[10] OECD Statistics 2014.

[11] See Utterback (1971) for an early contribution on the process of technological change at the firm level. Later contributions include Cohen and Levinthal (1990), Dosi (1997) and a survey by Freeman (1994).

a new technology that would reduce employment and thereby costs, they will introduce this new technology to gain competitiveness (Acemoglu, 2002). This process continues until cost for capital and the embodied new technology is sufficiently high compared to the substituted unit of labor. Looking at the overall effects of technological change on productivity it is obvious that technological change led also to average labor productivity growth (Färe et al., 1994).

However, labor is not homogenous. Labor and labor markets are segmented, and the segments show clear differences in supply and demand conditions. A major qualitative difference between these segments is the qualification level. Markets for low, middle and high skilled labor can be distinguished. This differentiation is important with respect to the demand for labor. In this respect two streams of interrelated approaches or hypotheses are relevant. First, the hypothesis of *skilled-biased technological change*, and second the substitutability of various sorts of labor with capital which is discussed as *capital-skill complementarity hypothesis*. Both hypotheses imply that there might be a technologically driven shift in the demand for labor in favor of the more skilled labor. Higher skilled labor could be a complement to capital with a more sophisticated technology embodied and lower skilled labor is substituted by this factor bundle. As a result asymmetric relative supply and demand of low skilled, medium skilled and highly skilled labor will determine wages and wage differentials. Skill biased technological change (SBTC) may cause developments in labor markets which are asymmetric for different skill groups of labor.[12] SBTC is likely to have asymmetric effects on wages for different skill groups, and hence is sometimes made responsible for the observable increase in income inequality.

Earlier contributions on the aggregate effects of technology suggests that both technology driven skill biased demand effects as well as differentials in skill supply growth matter.[13] However, in the second half of the 20th century direct and indirect evidence have backed the dominant role of SBTC in the discussion of a declining relative demand for low-skilled workers (see Katz and Autor, 1999). When SBTC is considered more broadly, i.e. also including capital-deepening and organizational innovations, econometric and case study evidence furthermore indicates that the shift towards more skilled labor is accompanied with higher capital intensity and the introduction of new technologies across industries and across plants within industries.[14]

The reason for the increase in relative demand for highly educated labor is often associated with standardization, automation and information technologies, and later with routine tasks and non-routine tasks (Autor et al., 2003). One interpretation is that a first period automation of factory floors in the middle of the 1970s and 1980s primarily replaced low-skill workers (Autor and Dorn, 2013). At this stage middle skill workers were not affected by a job replacements due to new technologies. Thereafter however, since the end of the 1980s and the beginning of the

For a very recent overview on the drivers of innovation at the firm level see the Chapter 3 of the EBRD Transition Report 2014.

[12] Excellent surveys upon this phenomenon are provided by Katz and Autor (1999), Goldin and Katz (2009) and Acemoglu and Autor (2011).

[13] Early work includes Griliches (1969), Katz and Murphy (1992).

[14] More direct evidence in this direction is given by e.g., Autor et al. (2003) and also by Doms et. al. (1997). Machin and Van Reenen (1998) argue that automation and increasing capital intensity go along with higher skills. Technological change (R&D intensity) is closely linked to changing skill structure of wage bills and employment in the United States and six other OECD countries.

1990s this pattern has changed resulting in greater replacements of workers in the middle skill group. From the 2000s the focus of discussion moves away from the skill level as major subject of interest to the tasks described as continuum of routine and non-routine activities. This change from the pure factor of production view to a task view is in particular due to the impact of information technologies (Autor et al., 1998).

Due to the massive diffusion of computers and the introduction of microprocessor based technologies tasks so far performed by workers with medium skill levels could now be redefined as routine-jobs and be replaced or outsourced.[15] Computerization let to both a reduction of jobs and simultaneously a skill upgrading (Bresnahan and Greenstein, 1997; Autor et al., 1998; Machin and Van Reenen, 1998; Katz and Autor, 1999: 530-1555). This was also indicated by a wage premium on higher school labor who could use computers (Krueger, 1993; Autor et al., 1998; see also Katz and Autor, 1999:87). A polarization of job growth was the observable result.[16]

While the low skill segment seems to face job opportunities at low but rather stable wage level and the high skill segment gains, medium skill level jobs are under pressure.[17] The routine or semi-routine jobs often related also to activities in the administration and service sector become replaceable by digital routines controlled and individualized by high skilled personal. This process is on the way and predictably not at all completed in advanced economies. “Industrial Internet”, “Advanced Manufacturing”, or “Industry 4.0” are the current advertised buzzwords for the next cycle of industrial innovation (see e.g. Kagermann et al., 2013; or Davis et al., 2012). The visions of promoting groups suggests that even non routine job can be substituted by smart machines. Machines communicate via internet and control production, supply and demand processes by data analysis. The machine system generates their own conclusions and determines actions. Far less human interaction and decisions are required. Control and disposition is delegated from skilled labor to the machine.

Having a rather clear evidence for a shift in the relative demand in favor of higher skills the supply of skills can have an impact on the extent of inequality and inclusiveness. The demand shift for higher skills can be alleviated by an increase in education effort in advanced economies (Gregg and Manning, 1997). Political effort to increase education for high skill and high productive labor may open up job opportunities for a larger share of labor in this occupational segment. However, such effort may be successful only as long as education policy has a significant productivity effect.

To summarize technological change or more particular SBTC and RBTC generate a continued increase in relative labor demand for higher skilled labor, raising their relative wages. This improved the labor market position of high skilled workers, both in terms of employment opportunities and income opportunities.

[15] Bresnahan and Greenstein (1997) or Bresnahan et al. (2002) study changes in labor demand. Sichel (1997) gives an analysis of the overall impact of computers on the U.S. economy.
[16] See Autor et al. (2006, 2008) for the U.S. conditions, Goos et al. (2009) for Europe and Goos and Manning (2007) for the UK.
[17] See section 4 for more details.

However, technological changes not only changed industrial production but also the organization and functioning of the firm. Driven by new information technologies the organizational structure of firms is changing.[18] At firm level (Bresnahan et al., 2002) as well as on aggregate (Autor et al., 1998) there is evidence that information technologies are associated with a higher demand for skilled labor, managerial and professional skills, decentralized decisions and decreasing employment shares of lower-skilled production labor. This change in the organizational structure has implications for the wage structure in firms. Not only that firms can be seen more as a chain or network of tasks where separable activities can be easier outsourced, also different tasks can be redefined as routine or non-routine tasks. Hence, new technologies and innovations resulted in a change of the organizational structure (Morton, 1995) and the relative wage structure (Acemoglu and Autor, 2011: 1159; Garicano and Rossi-Hansberg, 2004; 2006).

Hence it becomes important to further look at the implications of changing organizational structures. This is especially important because these changing organizational structures are a major link between advanced and developing economies and themselves affect the allocation of rents.

3.2 The disassembled industrial firm

Firms, being production entities operate distinct from market mechanisms. In particular multinational enterprises (MNEs) play an increasingly influential role in shaping the global distribution of income. Their importance has evolved along with technological progress and an increase in organizational complexity. This growing complexity and the way in which it affects the distribution of income are discussed in the following paragraphs.

In the traditional views of the firm, the firm has clear boundaries. In early theory the firm and the open market are described as the two institutional structures that make up the economic system (Coase, 1937). It is described as a dichotomy of firms and markets where firms are "islands of conscious power" (Coase, 1937: 388) within which market transactions are eliminated and replaced by an entrepreneur who directs resources. In this framework, economic agents organize their production in firms when the transaction cost of coordinating production through the market exchange is superior to within the firm (Williamson, 1975; 1985; 1989). In the *resource-based view* of the firm, a firm is characterized by the accumulation of firm-specific resources that are bound to the firm and can be used over the long run. These resources result in competitive advantage and rents (Peteraf, 1993; Wernefelt, 1984). In the ideal capitalist model, the owner of the firm generated and followed his business idea, was a major provider of the firm specific capital, was fully liable to external financial sources and hence took the full risk of a business idea. He was rewarded as entrepreneur for a good idea and for taking the full risk.

IT and communication technology have changed the information and transaction possibilities of the firm as an organizational entity and the structure of the organization, in particular by facilitating decentralized coordination (Dibiaggio, 2007; Farrell, 2005; Ghemawat, 2003). Thus, technological progress, among other factors, has given rise to new organizational forms

[18] Bresnahan and Greenstein (1997) describe how computers affect organizational practices.

and the blurring of firm boundaries (Heydebrand, 1989). Increasingly complex structures have emerged in several dimensions.[19] There is increasing complexity in terms of markets and products (Miller et al., 1995; Hobday, 1998; Henderson and Clark, 1990; Iansiti and Khanna, 1995), technology (Granstrand and Sjölander, 1990), production processes (Urbanic and ElMaraghy, 2006), and in terms of the integration of highly specialized and differentiated tasks and functions (Child 1973; Damanpour 1996). The latter includes the separation of ownership and control (Fama and Jensen, 1983; Prendergast, 1999; Williamson, 2002). The separation of decision making and risk-bearing can survive because of benefits of managerial specialization on the one hand and contractual bounds on the other hand, which allow to align incentives and infuse order.

Not only the holding and controlling of resources but also how resources are managed over time has become critical to the creation of value and firm performance (Perks and Moxey, 2011; Sirmon and Hitt, 2003; Sirmon et al., 2007). The management of resources, in an inter-temporal framework, includes structuring the resource portfolio, building capabilities and deploying them. The *resource-based view* has increasingly become a *capability-based* or *knowledge-based view* of the firm (Grant, 1996; Helfat and Peteraf, 2003). The economics of knowledge are characterized by an asymmetry between knowledge acquisition and knowledge utilization (Demsetz, 1988). The acquisition of knowledge requires a stronger specialization than its utilization. When different types of specialist knowledge have to be combined in production, market coordination fails for two reasons (Grant, 1996). First, tacit knowledge is immobile. Often productive knowledge cannot be fully and explicitly captured and is bound to individuals or entities (Teece, 1998). Second, there is a threat of seizure of explicit knowledge by others, which means the erosion of a firm's competitive advantage. Under these conditions, firms provide the governance structures that are necessary for productive exchange.[20]

The task boundaries of firms and the knowledge boundaries do not necessarily coincide (Dibiaggio, 2007; Patel and Pavitt, 1991; Brusoni et al., 2001; Takeishi, 2002). Multi-technology firms often have excess knowledge in production. Routine tasks can be codified and automated or transferred to other organizational units or firms. Also specific development tasks, such as the design and manufacturing of individual components, can be transferred when the requirements are clearly specified and the organizational units or cooperating firms possess the necessary know-how or have access to it.[21] The strategic decision to outsource or offshore production is different from the decisions to divest technological knowledge. While an increasing share of technology is being located abroad by leading multinationals, the dimensions of the process of technological globalization is controversial (Dibiaggio, 2007; Cantwell and Santangelo, 1999; Ghemawat, 2003; Patel and Pavitt, 1991; Patel, 1995; Santangelo, 2001). The technological core of multinationals often remains at the home base (Patel and Pavitt, 1991; Patel, 1995).

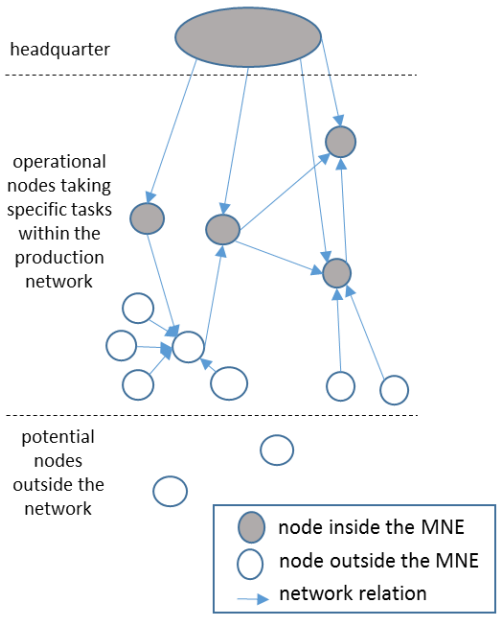
The partitioning of activities, or tasks, be it via outsourcing or offshoring, can be analyzed in terms of a global disaggregation of the value or supply chain by which companies strive to

[19] See Wang and Tunzelmann (2000) for an overview.
[20] See Williamson (2002) for a conceptualization of firms as governance structures.
[21] See, e.g., Takeishi (2002) for a study on automotive product development, and Brusoni et al. (2001) for a study on the development of control systems for aircraft engines.

combine comparative advantages of geographic locations with their own resources and competencies to maximize their competitive advantage (Mudambi and Venzin, 2010). Today's large multinational firms can be considered as value networks that are linked by organizational ties. The organizational problem largely concerns the control and efficient use of resources and knowledge (Quinn, 1992; Garicano and Rossi-Hansberg, 2004; 2006; 2014).

In the framework of a *value network* the organizational entities that constitute the nodes of the net are highly specialized and contribute capital, embodied in technology as well as tacit and explicit knowledge and (specific) human capital, for the completion of (specific) value generating tasks. For ease of discussion, two types of network nodes are distinguished. The first type is the strategic and technological center. While entities within multinational organization networks are mutually interdependent and not necessarily characterized by hierarchical layers, the locus of major strategic decisions is typically still the headquarters (O'Donnell, 2000). The second type of node has an operational nature. Nodes of this type can be considered close to the notion of tasks described by Acemoglu and Autor (2011). Within operational nodes, the assignment of skills to tasks is determined by labor supplies, technologies and task demands. The aforementioned interaction between skills and technology is present also at the organizational level.

Operational nodes can be substituted with one another also with entities from outside the network. At the same time, operational nodes can be split off the controlled network (outsourced or fully excluded from the scope of the firm). In brief, the shaping of the network is a matter of vertical and horizontal integration. Firms' links between nodes can present links between the industrial sectors of developed and developing economies. Interactions between nodes in the form of FDI and trade are particularly relevant with regard to the interacting development of the industrial sectors.



Box: Disassembled industrial firms

The headquarters of globally disassembled firms, i.e. production networks, are usually located in advanced economies and are the central network nodes. They take strategic decisions on the structure of the production network and in this way also on the distribution of rents.

The network comprises operational nodes that are responsible for carrying out specific tasks. This notion of operational nodes is closely related to the notion of tasks described by Acemoglu and Autor (2011).

Operational nodes may be possessed by the MNE (shaded in grey) or be legally independent from the MNE (white). They can be substituted with other nodes from within or outside the network.

The firm, as a disassembled network, differs significantly from the classical firm in its characteristics, in the way it operates and in the way that rents are generated and appropriated. Typically, a central organizational unit concentrates knowledge about the optimal available combination of external and internal nodes, which can be very dispersed with regard to operative content and location. The central organizational unit often has a low physical capital stock and may be almost virtual (Calpado, 2007; Perks and Moxey, 2011). Knowledge and human capital are partially firm specific, i.e. they are a firm specific asset. While in the ideal capitalist model, the elements that define the firm are linked to the (share)holder of the physical capital asset, in today's firm many of these components are linked to the human asset.

Corporate decisions that comprise a high risk and potentially high rewards, like decisions on innovation strategies, are taken by knowledge holders with limited liability and capital holders. The organizational processes that follow these decisions usually involve the skills and efforts of people on different hierarchical levels with diverse functional specialties as well as capital from several sources. When these collective and cumulative processes yield positive outcomes in the form of rents, the question of the appropriation of these rents is, in terms of Lazonick and Mazzucato (2013: .1096), also a matter of an "ideology of who takes the risks". Where the organizational framework leads to a detachment of risk and rewards in the innovation process, Lazonick and Mazzucato point to "organization failure" rather than "market failure". Such a malfunctioning may not only emerge in innovation processes but also in other processes that are characterized by a collective, cumulative and uncertain nature.

Overall, the consideration of why economic transactions take place within organizations or via markets makes it apparent that firms and markets complement each other and can interact in a way that considerably shapes the local and global distribution of incomes and the inclusiveness of development. As a consequence of the organizational changes that have taken place, inefficient allocations of resources have become more likely and the discussion of inequality becomes inseparable from a discussion of organizational functioning.

3.3 Globalization of value processes and transfer of technological change to developing economies

Neoclassical trade theory suggests that firms in countries produce final products. After opening up for trade firms of 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 shaping whether or not structural transformation is inclusive or not.

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 main reasons are: (i) The diffusion of technologies, originally introduced in the advanced economies, is continuously shifting to developing countries. (ii) A

massive drop of trade restrictions and financial barriers led to easy cross border transactions in almost all regions of the world. (iii) The broad introduction of information technologies led to a new type of firm organization,[22] and (iv) a further reduction of 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 3.3 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 an increase in the value added in manufacturing by a factor of five between 1995 and 2009. Also Brazil, India, Mexico and Turkey show large absolute increases in global value chain income.

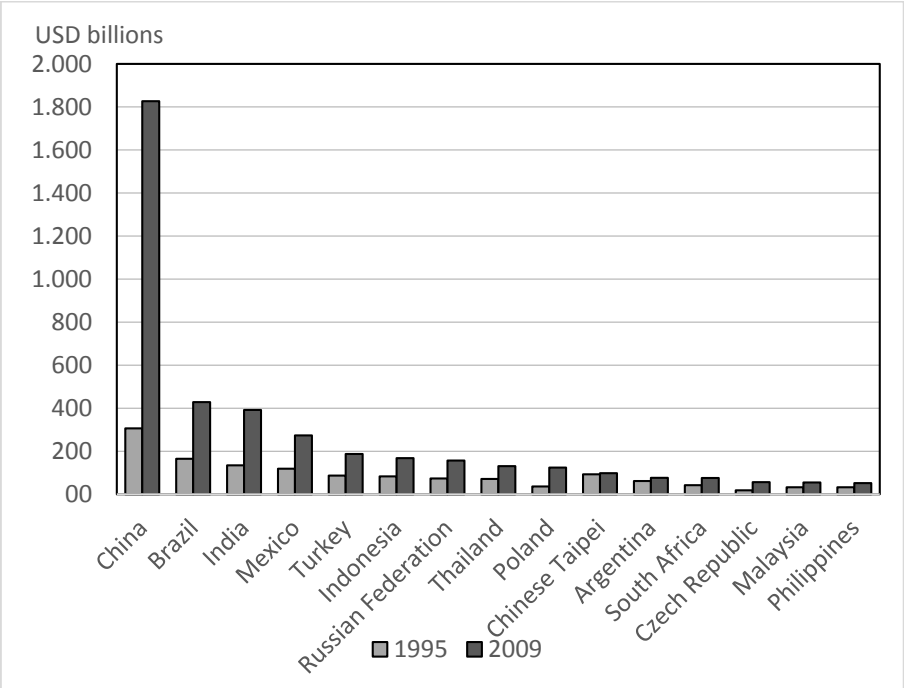


Figure 3.3. Value added in manufacturing global value chains, selected emerging and developing economies, 1995 and 2009 (based on OECD (2013)/ OECD-WTO Statistics on Trade in Value Added)

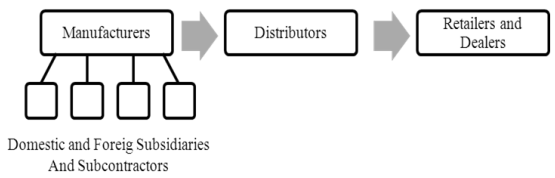
3.3.1 The globalized firm and technological linkage between advanced and developing economies

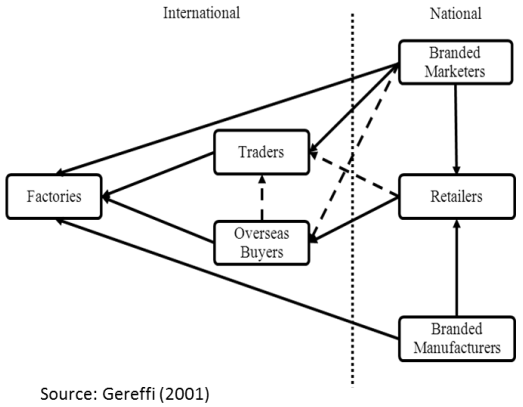
Approaching the firm as a controlled network, we can explore the linkage between the evolution of global production networks, the role of network leaders in transferring know-how, and the formation of capabilities by local suppliers producing for such networks. Global value chains may be classified into two distinctly different sorts. In one the "top-node" is an international producer (thus producer-driven) that controls the chain (e.g. an automobile manufacturer) in the other it is a large international buyer (thus buyer-driven) that exerts control by capturing

[22] See section 3.2.

strategic positions in marketing and design (Gereffi, 1994, 1999; Gereffi and Memedovic, 2003).

Box: Producer vs Buyer-driven Value Chains





Source: Gereffi (2001)

Producer-driven Value Chains tend to have high barriers of entry since many value chains require capital- and technology-intensive production and economies of scale. Under such circumstances, large, usually transnational, manufacturers play the central roles in coordinating production networks (including their backward and forward linkages). Examples: automobiles, aircrafts, computers, and heavy machinery.

Buyer-driven Value Chains tend to have low barriers to entry and refer to those industries in which large retailers, marketers, and branded manufacturers play the pivotal roles in setting up decentralized production networks. Producers are bound to the decisions of buyers through the functions of design and marketing. Examples: garments, footwear, toys, housewares, consumer electronics, and a variety of handicrafts.

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 thus become able to upgrade their technological and organizational capabilities. Participating in global value networks however, requires quick response times, meeting quality standards and being financially solid (Ernst and Kim, 2002). Linking to a global production chain affects the technology, imitation and upgrading conditions for local production clusters, and the chance to locally upgrade depends on the type of network a local supplier feeds into (Humphrey and Schmitz, 2002). Recent studies identified about 43,000 multinational enterprises with about 500,000 subsidiaries (Glattfelder, 2010: 92-94). Figures 2.3a and 2.3b illustrate corporate connections with the 2005 Fortune Global 100 multinationals, which accounted for 27% of OECD revenue in 2005. The first map in figure 3.4 shows the number of outgoing connections (from local headquarters to abroad subsidiaries) while the second map shows the number of incoming connections (from abroad headquarters to local subsidiaries). A comparison of the maps reveals a wide dispersion of corporate activity across the globe while the headquarters are concentrated in a few countries.

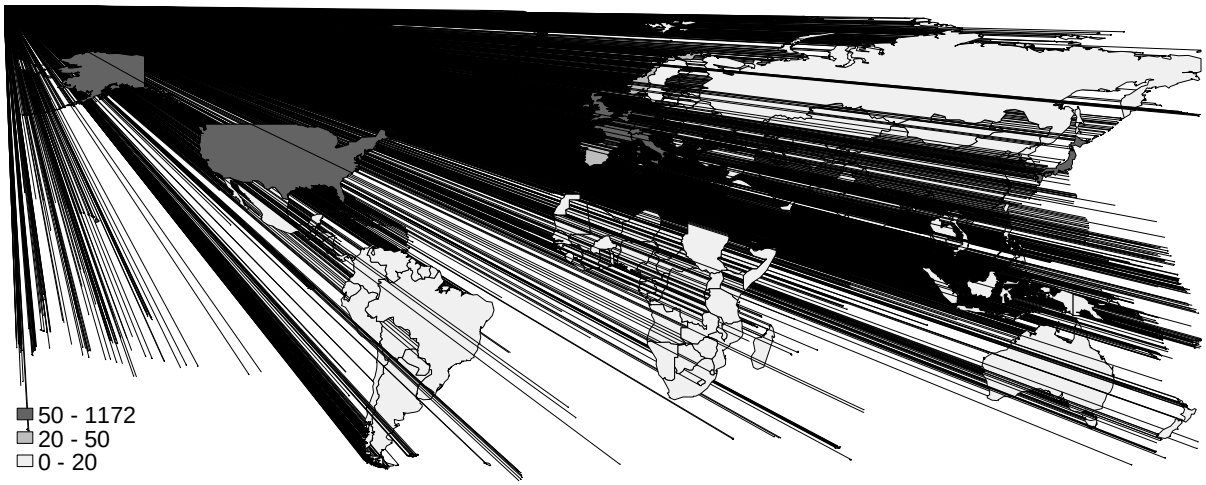


Figure 3.4a: Number of Fortune 100 MNC outgoing corporate connections (from local headquarter to abroad subsidiary)

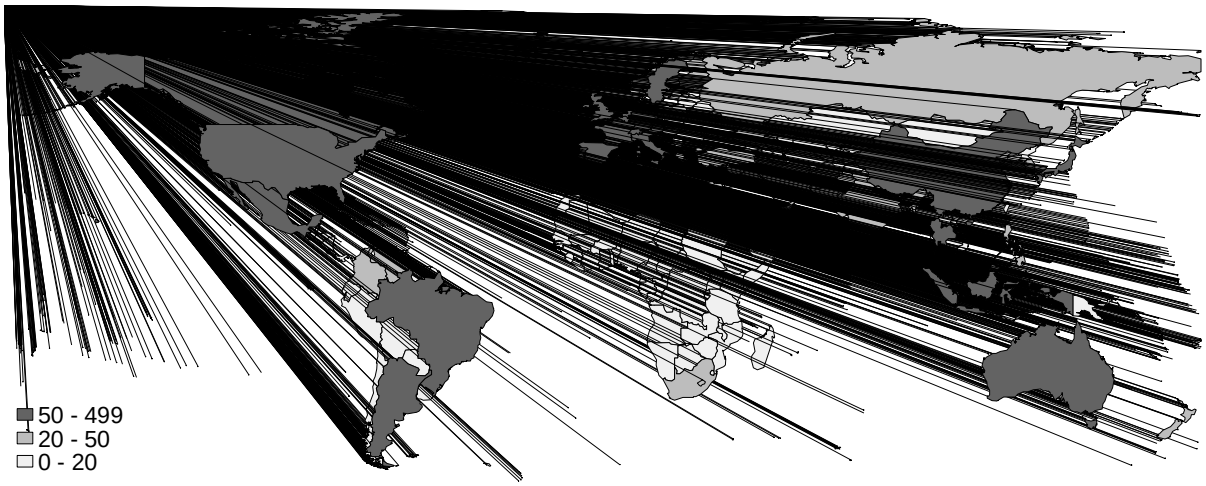
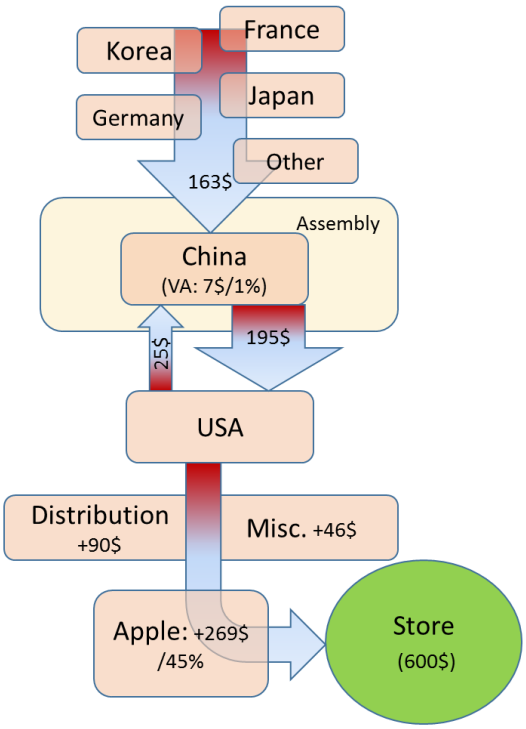


Figure 3.4b: Number of Fortune 100 MNC incoming corporate connections (from abroad headquarter to local subsidiary)[23]

[23] Based on Table A1 in Wall et al. (2011) and open-source shapefiles from www.diva-gis.org.

Box: Value added and captured in the Iphone 4 global value chain



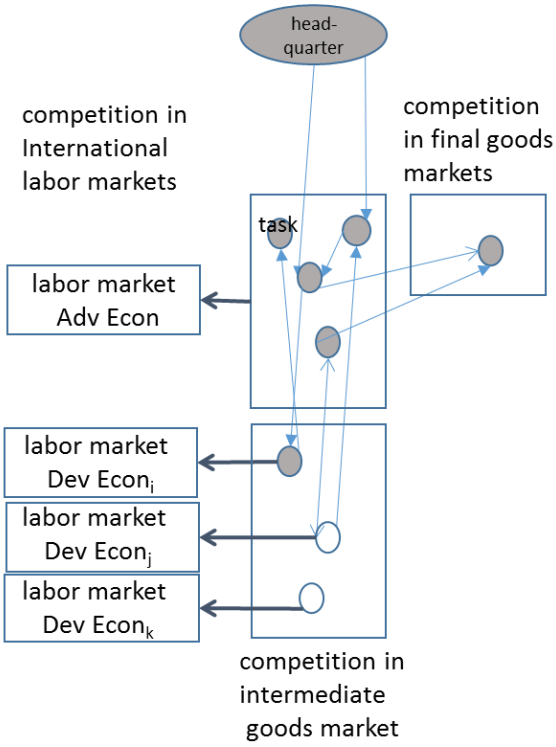
The IPhone 4 may serve as a good example to demonstrate the value added and captured in an global production chain. It is assembled in China and (in the example) sold in the United States at a store price of 600$. While the Chinese factory receives inputs worth around 188$, the factory gate price is a mere 195$. Taking distribution and other costs into account and given a store price of 600$, the designer and marketer (Apple) captures almost half the value added.

Source: Adapted from information in OECD (2011b) and put together for illustrative purposes. Precise numbers may vary.

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. Governance is also the major difficulty in such large value networks. Capabilities of supply-bases, the complexity of transactions, and the ability to convey transactions are 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 knots) and out-of-firm externally owned nodes. It becomes also easy to think of domestic value generation at different locations including international sourcing of tasks. In such a value network there is a central node or small set of nodes which define the center and a periphery consisting of nodes which are needed but less important to define the firm's characteristic capability. As described above such a central node stands for the headquarters and the strategic management.[24] It represents the current capability of historic developments and knowledge accumulation. Hence, the de facto head office (i.e. the center for strategy and governance) of most transnational firms is located and owned in advanced economies. At this central node we find the decision on sourcing.

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



Box: Determining of rent distribution

Global value chains generate both, a higher efficiency through a better adjustment to comparative advantages and rents.

The distribution of rents however, is determined by competition in various markets. If there is high competition in intermediate goods markets and excess supply of labor in developing economies' labor markets, labor in these countries is less likely to gain rents. If there is high competition in final goods markets most of the rents will be allocated to final costumers.

If rents can be broadly generated in the value network their distribution depends on relative power in the network. In this regard they may be either entirely distributed to captial owners and/or management, but also to broader stakeholders such as the workforce or for environmental concerns.

What are the sourcing questions? First, which nodes are within the firm or outside the firm? That is the question which tasks and services are produced by the firm itself, or which tasks are outsourced and imported from other firms. The second decision on the sourcing of tasks is about the location of a certain task on the globe. Which nodes are best produced in the home country of the firm and which nodes are produced best internationally. The international production can be either the result of an FDI or the result of an imported task from a foreign producer.

International sourcing is not just placing a certain task to a certain location. For such a firm the key element of international sourcing is linking up the firm's technology and know-how with comparative advantages of a production process at 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 are determined by the interplay of comparative and competitive advantage (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 of staying internationally competitive. Both elements also increase the firm's income that can potentially be distributed to different groups of stake holders within the firm.

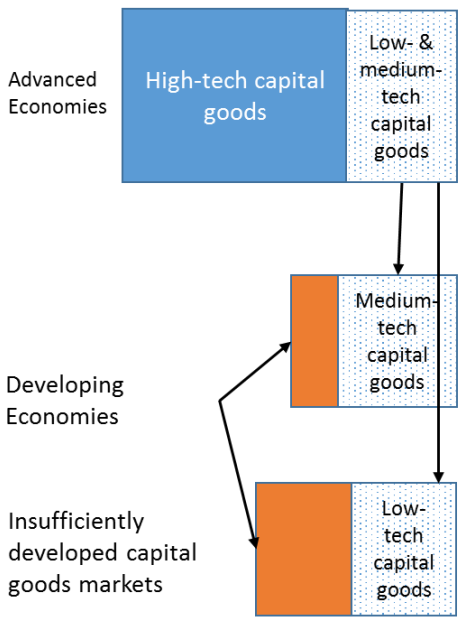
In light of the above it is not surprising that we could observe such a massive wave of globalization during the last three decades. When the sourcing decision is done each node is allocated according to country- or region-specific comparative advantages. Hence, tasks of the production chain are allocated all-over the globe. At least in an early stage of development these sourcing decisions often define the major link between advanced economies and industry development in developing economies. These decisions imply the crucial transfer of technologies and know-how that enables developing countries and regions to become elements of a global value network. This technology and know-how transfer enables the lagging

industries to match current standards and qualities to find a channel to the market for tasks related to modern (non-primary) sector value adding. In later stages of development this technological link is often substituted by an imitation process. In this imitation process domestic entrepreneurs substitute for the function MNEs had so far. In this stage domestic entrepreneurs increasingly organize this link to the international value chain and the technological upgrading process by imitation.

3.3.2 Perspective of the developing economies

Switching the perspective to developing countries with respect to the described technology linkage raises a number of question. (i) Why is this link important for domestic modern sector development? (ii) What are the conditions that a node in a developing country emerges?

Why is the link important? In early stages of development countries are dominated by an agriculture or semi-agriculture structure. This causes two problems, one is at the demand side and the other is at the supply side. At the demand side, in many smaller countries there is no sufficient income and productivity for a large share of population to purchase goods produced in a modern industrial sector. Neither final products nor intermediate goods or tasks for an industrial producing value chain have a domestic market (Tybout, 2000). At 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 a competitive product to domestic customers. Thus, a simultaneous lack of market and technological capability leads to a prohibitive barrier for developing a domestic modern sector. Therefore, the international link can potentially solve for both problems.



Box: Capital goods market for medium- and low-tech technologies

Capital goods embody technologies. Newest and most valuable capital goods are those investment goods with the latest most sophisticated technologies. These capital goods are produced almost completely by firms of advanced economies.

When technologies become older these capital goods move as vintage technologies to developing economies. At the time when they move they are already degraded as medium- and low-tech capital goods.

In developing countries high-tech capital goods are not broadly produced. In these countries medium-tech or low-tech capital goods represent the technological capability. However, even these kinds of goods are more likely to come from upper middle income countries. This limited capacity of capital good production may limit industrial development.

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 to the ability that the country can adjust to the technological

standards, qualities and requirement. 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 so far were limiting factors of developing a modern sector.

What allows a country to become integrated into these global production processes? What allows international connectivity and industrial development? International connectivity is a necessary but not sufficient condition for modern sector development. Hence let us start with the question of connectivity to global value networks. Certain local conditions in the developing economy are required, which together with a technology transfer from an advanced economy, combine such that the resulting task matches to a competitive node in an internationalized value network. That is access to international value chains and markets as well as a technology transfer are the external conditions. Sufficient favorable local conditions in the host country of the emerging modern sector have to be added. What are these local conditions that can promote international connectivity for a modern sector in a developing country?

The local conditions may vary depending on the international value network. More specific it makes a difference if the international network is a producer-driven network or a buyer-driven network.

A producer-driven network often imports specialized and more complex tasks under direct and very detailed control of the central node. Buyer-driven global value chains represent an internationally dispersed production system characterized by high competition and local ownership. Profits arise mainly due to design and marketing activities captured by developed-market retailers or branded manufacturers (Gereffi, 1999).

However, even if many locations may offer an environment for a successful node a number of local conditions are typically important for a successful realization of comparative advantages and become able to achieve technology transfer and its benefits (Coe and Helpman, 1995; Coe et al., 1997, 2009).[25] (i) A sufficient level of skilled local labor and human capital (Barro and Lee, 1993; Barro and Sala-i-Martin, 1995; Schultz, 1999), often at least secondary education; (ii) sufficient functioning of 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 like property rights or freedom of contract, administrative institutions with low level of corruption and reliable contracts, legal institutions law enforcement; a predictable policies, stability in general and a stable political system (Przewoski and Limongi, 1993; Fischer, 1993); (iii) reliable power supply, a local transportation infrastructure that allows for mass transports often closeness to a port allowing for shipping, (iv) a working financial sector (King and Levine, 1993); (v) local communication infra-structure in terms of telecommunication and internet access; (vi) entrepreneurship (Gries and Naudé, 2011) if the link is to be organized by the local firms.

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

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

3.3.3 FDI as transmission channel for technological change in developing economies

In the current context the interpretation of FDIs is the sourcing of a node towards an international location. The purpose of the FDIs we consider here is industrial production of an (intermediate) good or task. The purpose is not the development of a new market or penetration into an existing market.

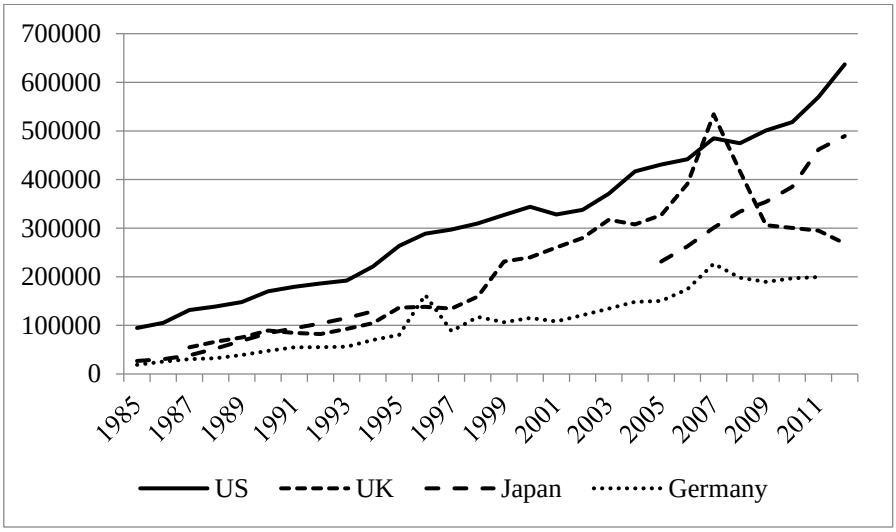


Figure 3.5: Outward FDI into manufacturing 1985-2012 (US dollar, millions)(OECD, 2014)

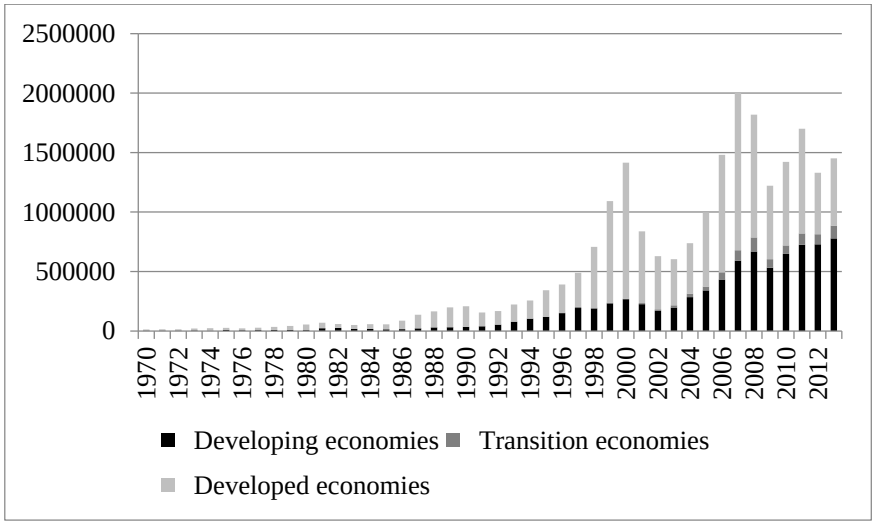


Figure 3.6: FDI inflows, by country groups, 1970-2013 (Millions of dollars)(UNCTAD, 2014)

Figure 3.5 shows that manufacturing at international locations has strongly increased over the last 30 years. MNEs globalize their production activities. Furthermore, developing and transition economies are included strongly in this global production. Figure 3.6 gives an idea about FDI receiving country groups. Figure 3.7 shows how FDI flows are distributed among global regions.

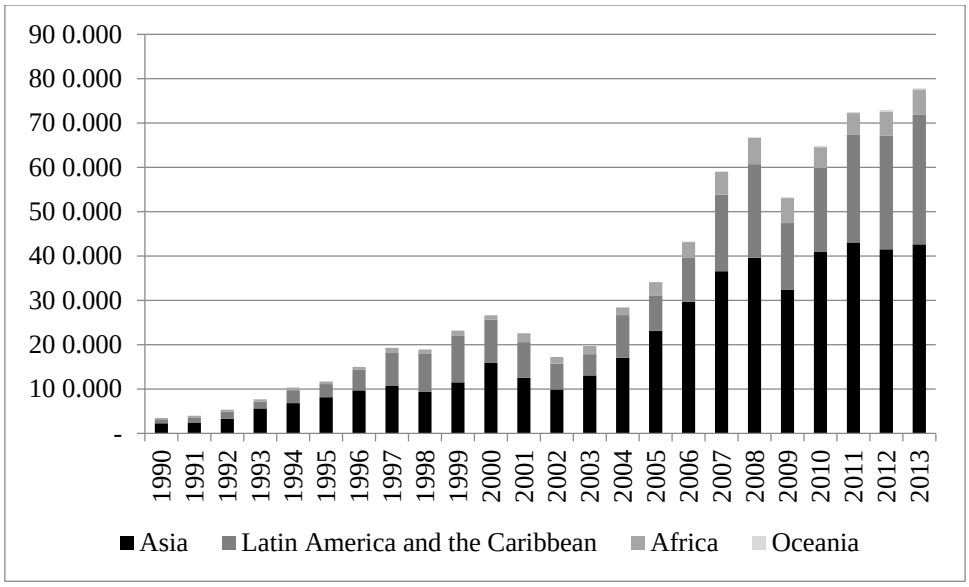


Figure 3.7: FDI inflows in developing economies, by region, 1990-2013 (Millions of dollars)(UNCTAD, 2014)

Via the vehicle of international investment there is a transportation of the investment embodied technology or knowledge to the target country which may lead of a technology and know-how transfer. However, the quality of this technology or know-how transfer can differ widely. Technological linking up has a number of implications for the host country of this node that is integrating in the global value chain:

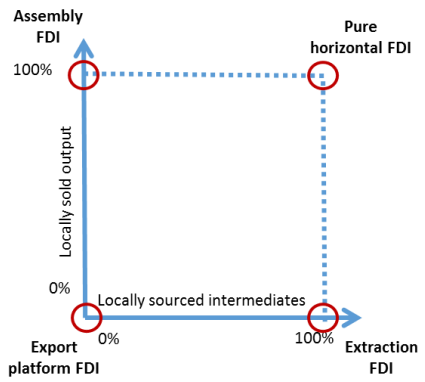
(i) The use of a technology can be directly transferred to the international location in a LDC country, e.g. assembling via FDI.
(ii) Technologies can be completely or partially directly transferred to the other country location which is controlled by the local branch.
(iii) Technology spill-over linkage effects as complementary effects.
(iv) New technologies require human capital and encourage local investments in human capital.
(v) Linking up to global value chain causes a link to a specific set of technologic solutions and causes technologic dependence. Periphery nodes have to adjust to the chain technology.
(vi) An adjustment to the quality standard is required, the conditions are defined from outside.
(vii) A technology developed out of the conditions and requirements of the advanced economies may not perfectly fit to the conditions of the developing economies.

However, as in a developing economy there is no other technology available a location of an industrial production task (FDIs) is positively affected. .[26] Empirical findings suggest that FDI

[26] Borensztein et al. (1998) show in a theoretical model how FDI increase long run growth rates by inducing technological diffusion from advanced economies to host countries. Xu (2000: 491) states that "the level of human capital is crucial for a country to benefit from technology spill-over of

is an important vehicle for the transfer of technology if the host country has a minimum threshold stock of human capital (Borensztein et al., 1998).[27] The international investment will create jobs and absorbs labor from the Lewis labor pool. There may also be spill-over and forward and backward linkage effects if entrepreneurial ability allows to connect to the foreign firm and its technological requirement. For China e.g. FDIs led to technology transfers in Chinese manufacturing firms.[28] Two effects occurred: 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 plant (Rodriguez-Clare, 1996).

Box: The Sales and Sourcing box of FDIs



Source: based on Baldwin and Okubo (2014).

FDIs may be classified according to the share of intermediates that they source locally (horizontal axis) and the share of output that they sell to the market that they are located in (vertical axis). Four stylized extremes with different characteristics emerge:

The *southwest corner* represents a pure outward processing FDI, known as export platform. All inputs are imported and no output is sold to the domestic market.

The *northwest corner* represents assembly FDI, where all inputs are imported while all outputs are sold in the local market. In the *southeast* corner, resource extraction FDI can be found. Inputs are sourced entirely from the local market (this is often the case for natural resources) but all produced goods are exported. The last extreme, in the *northeast corner*, is a pure horizontal FDI. This type sources and sells locally 100%. Naturally there exist many mixed types in between.

Backward linkages present an important aspect for broad participation in the transfer of technology (Liu, 2008). Therefore, the more local upstream businesses are integrated into the network, the higher the potential diffusion and spillover of technology. However, the beneficial process may be of limited applicability if the local intermediates only contain local (natural) resources that are being extracted.

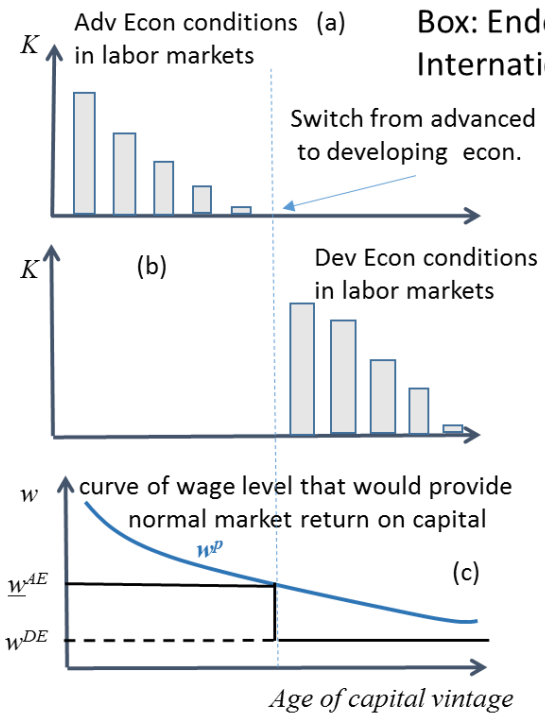
Still, these overall positive effects can often be restricted. Often the technology transfer consists of an assembly line producing a specific task for the international value chain. The assembly line was introduced years ago in the production process of the advanced economies representing the up to date technology under the wage-return conditions of the advanced economies at that time. 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

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) suggest a theoretical model of catching-up through technology transfer by FDIs.

[27] Nair-Reichert and Weinhold (2001) show in dynamic panel causality tests that FDI has a strong positive causal impact on GDP growth.

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

the same number of workers employed would now – after this depreciation process of the machine - costs much less and hence could be sold or newly installed as labor intensive capital good.



Box: Endogenous technology depreciation, International capital allocation and rents

The diffusion of technological change and the ability to generate rents by global allocation of capital can be understood by applying the concept of vintage capital.

In advanced economies a new technology is introduced through a high value capital good and combined with n workers. This investment results in a high capital intensity. In the following periods this technology competes with then newer technologies and hence is gradually depreciated. At wage $\underline{w}^{AE}$ the capital vintage is not profitable anymore and fully technologically depreciated under the wage conditions of advanced economies (a).

Under low wages of developing countries however, this technology is still profitable and has a lower, but still positive value. Transferring the capital vintage and run it again with n workers leads to a profitable production with low capital intensity (b).

(c) Draws a curve of the wage level that leads to a profitable use of the capital vintage. However, after moving vintage capital to DEs the wage gap $\underline{w}^{AE} > w^{DE}$ provides rents as w^p is above w^{DE} .

There is an optimal 'switch point' when 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 new replacing capital and technology. Hence, capital with the embodied technology vintage transforms via depreciation from capital intensive to labor intensive and 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.

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, it is a limited amount of capital which 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 due to the direction of technological progress in the advanced economies using even less labor.

Hence, the installation of capital goods from advanced economies would limit job creation as long as there is no sufficient investment good industry that fits more precise to the labor abundance in developing countries. Another disadvantage of a technology transfer via FDI is that by definition the control of the process and the transfer is in hands of the foreign investor.

Box: FDI as a channel for technology transfer: The case of Costa Rica

Costa Rica is a leading example of how the participation in global value chains can be facilitated by policies that are aimed at fostering FDI (see OECD, 2012; 2013; Giuliani, 2008). During the 1980s and 1990s, Costa Rica adopted a modernization strategy based on attracting high-tech multinational companies (Giuliani, 2008). Foreign affiliates have played a dominant role in the development of a high-technology industry and diversification of exports towards knowledge-intensive products, such as microprocessors, medical equipment and IT-related electronic goods. By 2011, the FDI stock amounted to 37% of GDP, which is second largest in Latin America behind Chile. More than 150 foreign companies brought in FDI in services, advanced manufacturing and medical devices and export volumes have increased dramatically.

The factors that enabled the development of the high-tech industry include high levels of secondary and tertiary education in combination with relatively low wage costs, the provision of services to investors, the establishment of free trade zones, active promotion of exports, and bilateral investment treaties. Last but not least, a stable political situation has provided an indispensable ground for high-tech FDI.

The literature on positive spillover effects on the Costa Rican economy is inconclusive. At least some positive spillovers have been generated by Intel, the most important player in the Costa Rican high-tech industry, in the form of training programs in higher education institutions (Larraín et al. 2007).

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 a rather close integration into the international value chain and an already sophisticated technological and skill potential often these kind of nodes are located either in the advanced regions or emerging economies. Such high degree specification and specialization within such producer-driven networks may limit the quality of technology transfer. It may reduce 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 location. An example for such a threat could be that a producer's network is able to choose between different competing locations for a task. After a period of production in one country a competing location in another country becomes more interesting such that the existing task in one country is moved away to another country. As a result much of the technology transfer is reversed. Even the local firms which might have clustered around the foreign production unit are disconnected from the global chain such that large parts of the industrialization and modernization process was not sustainable.

3.3.4 Trade as transmission channel for technological change in developing economies

While in the above discussion the focus was on the FDI procedure and the implied technology transfer trade was already an essential element of the argument. In fact the mechanism described in the above section 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, this node needs to import other tasks from the global network, and after the intermediate good is produced the node will export the intermediate good into the global

network. Hence, international trade is an essential element in the FDI mechanism which is connected to the technology transfer.

In the above discussion FDI and trade were closely related. However, FDI related trade is trade within the firm. This trade is an import and export of tasks within the firm and not a trade as a result of a competitive process in an open international market. Furthermore, while within firm trade is an activity governed by a MNE from an advanced economy, trade in the following context is meant to describe trade between independent firms on the demand and supply side via an international market.

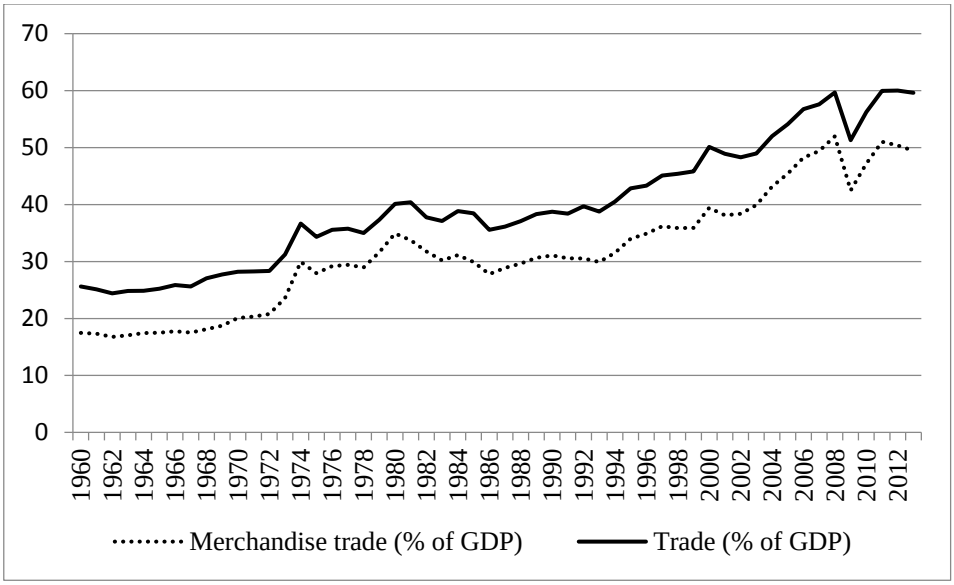


Figure 3.8: World trade and merchandise trade as percent of world GDP, 1960-2013 (World Development Indicators, 2014)

Figure 3.8 shows that trade expanded more than GDP leading to an increase in the trade to GDP relation over long time. Hence, global interactions and interdependence has increased. These increasing interactions indicate both, increasing exchange of final goods and increasing activities within global value networks revealed by the increase in intermediate goods trade. Figure 3.9 depicts the increase in total value of intermediate goods' trade which accompanies a rather stable share of intermediate imports in total imports.

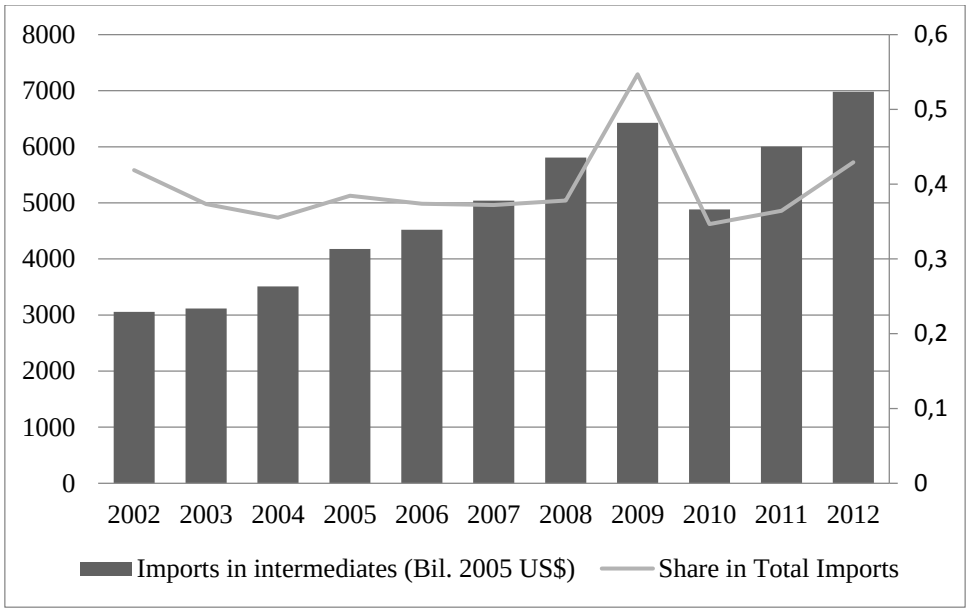


Figure 3.9: Trade value and of intermediate products and share of total trade (World Trade Organization, 2013)

Trade in this context is more related to the classic idea of trade through a market in which tasks or clearly definable intermediate products are exchanged. Therefore, we also need to discuss how international trade leads to a transfer of technologies and knowledge to developing backward countries. The major mechanism is imitation.[29] If 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 connectivity to an international value chain and the respective requirements defined by this chain are again the key conditions for a technology transfer through imitation.

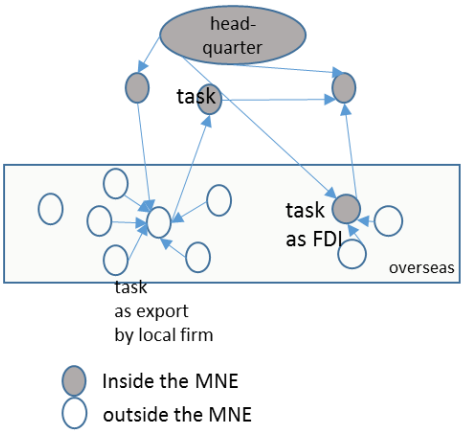
[29] Trade as vehicle for technology transfer is widely discussed in trade based endogenous trade theory originating with Helpman (1992), Grossman and Helpman (1991), Rivera-Batiz and Romer (1991), and Young (1991), Gries and Jungblut (1997), Edwards (1998), Greenaway et. al. (2002).

Box: Trade as a channel for technology transfer: The case of China

As shown in figure 3.3 and elaborated by Lemoine and Ünal-Kesenci (2004), China's integration in global value chains has increased tremendously over the last decades. Highly competitive industries based on imported technology and foreign affiliates have developed. Exports in manufactured goods have diversified and shifted from textile products to electric and electronic products.

The shift in specialization from labor-intensive industries towards higher-technology sectors, i.e. technological upgrading, is related to trade policies favoring processing activities that were introduced starting in the 1980s. On the import side, the Chinese government used tariff exemptions on inputs used in the production of exports (Ianchovichina et al. 2000). Furthermore, China reduced its average customs tariff from 41% in 1992 to 16.8% in 1998-2001. In 2001 China has become a WTO member. In 2010 China accounted for 19% of world manufacturing value added and has become the world's leading manufacturer (OECD 2013). The share of processing trade exports, i.e. exports for which raw and ancillary components have been imported, makes up about half of total exports.

However, the international technology transfer is not automatic as in the FDI case even if it may be more sustainable. An imitation process is a demanding challenge not only in terms of the technological imitation, but also in terms of organizational and communicational abilities. Therefore, not only sufficient technological and engineering skills, sufficiently skilled labor or all other important determinants of a location are important for such a successful imitating firm. Most important or even a precondition is a sufficient entrepreneurial capability.



Box: International connectivity of local entrepreneurs

Technical diffusion may follow two channels. One channel works via FDI and trade and is mostly dominated by firms of advanced economies.

Another channel is opened and operated by domestic entrepreneurs of developing economies and driven by trade. A necessary precondition is their ability to connect to global value networks.

With domestic entrepreneurs routed in the local economy spill overs can be expected to be larger and dependence on external decisions is less.

However, to connect is challenging for entrepreneurs in developing economies as they must have technical, business, organizational and communicational capabilities and sufficient flexibility to be able to imitate and keep up with technical innovations. These abilities are often beyond the abilities broadly available in developing economies. A lack of high and directed education towards such abilities seems a limitation for well functioning entrepreneurship.

Entrepreneurial activity is crucial to discover what a country is good at producing. Even though the social benefits of entrepreneurial activities may be large local conditions may lead to an undersupply of entrepreneurs (Hausmann and Rodrik, 2003). However, local entrepreneurs are responsible for the match of the output profile of his firm with the requirements defined by the

international network. This forces to adjust to changing technologies and organization conditions and lead to a technology and knowledge transfer by imitative learning. This activity is much more difficult and demanding than just being - via FDI - an outsourced node governed by a foreign head-quarter. However, such imitative learning improves the chance for a sustainable transfer of technology and knowledge to the local economy. The production technology is mastered and controlled 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.

However, the above discussion assumes ideal conditions. Buyer-driven networks operate slightly different. In the 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 the production process is neither horizontal nor vertical very deep compared to producer driven chains. Profits are from design and 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 learning by producing and adjusting to technologies and qualities introduced in such a value network.

Even if the governance structure is less predefined as 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 of high income economies. They possess a detailed knowledge of how to successfully govern such a buyers-networks network (like fashion labels) from a location in advanced economies. Therefore, even if connectivity to international markets exist and technology transfer occurs, inclusiveness is limited. However, the pure fact that there is a production organized by local entrepreneurs and potential forward and backward linkages are positive elements of this phenomenon. Also, learning by imitation can be an effect generated by this kind of connectivity. Local entrepreneurs may become able to start their own buyer's networks for a domestic market. Furthermore, markets of other developing countries may become a target for entrepreneurs who have learned by imitation and who now can use the transferred 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 inclusiveness for a larger part of the world in industrial development.

What are the effects of the described mechanisms? What are the effects of technological change, and skill biased technological change on the advanced economies and developing economies in particular when having in mind the issue of inclusiveness? What are implications of a technology transfer from advanced to developing economies? Are most people included in the benefits or are major groups excluded from global productivity growth? The next section starts with analyzing the effects of technological change on advanced economies.

4 Effects of technological change and international technology transfer – the perspective of advanced economies

Having introduced the major elements connected to original technological change, the diffusion and transfer of technologies and inclusiveness, we can now turn to discuss the effects generated by these new technologies. We focus on the question of inclusiveness and try to answer the following questions. Which groups benefit more or less from potential merits of technological change? Were the benefits inclusive for a major share of the population or could basically small groups take advantage? Which are the reasons that led to non-inclusive growth for a larger share of the population? We try to answer these questions first for the situation within *advanced economies.*

4.1 Is the growth process inclusive in advanced economies?

During the last three decades we can observe a polarization of societies in advanced economies. The polarization has two dimension, a polarization of (i) income or wages respectively, and a polarization of (ii) job characteristics associated with different income levels.

The first dimension indicates the development of income ratios. The standard picture to look at is the ratio of wage rates for various income groups of the income distribution. Various indicators are interesting to look at: figure 4.1 shows for example the development of the ratio between the 90th and the 10th percentiles and thus reflects the relative evolution of the two extreme poles of the income distribution. It is therefore capable to indicate income polarization.

According to these long term trends we can see - except for Japan – an increase in income inequality. As far as the middle income group is concerned, as is shown in figure 4.2, differences between Germany and Japan on the one hand side and Anglo-American countries on the other hand become visible. The relative loss of the middle class is obvious and much stronger for Anglo-American countries. For Germany and Japan the relation between rich and middle incomes was volatile but increased only marginally over the full time range. Relating middle income percentiles to low income percentiles (also in figure 4.2) indicates if these two groups converge or not. For the U.S. there seems to be an increasing divergence in incomes, as both relations have hugely increased. The hypothesis that the US is moving towards strong income polarization can thus be visualized in these diagrams.

For the UK the relation of middle to low income remained almost unchanged, and for Germany middle income did not lose against the highest, but gained against the lowest since 1996, while in Japan middle income lost against the lowest.

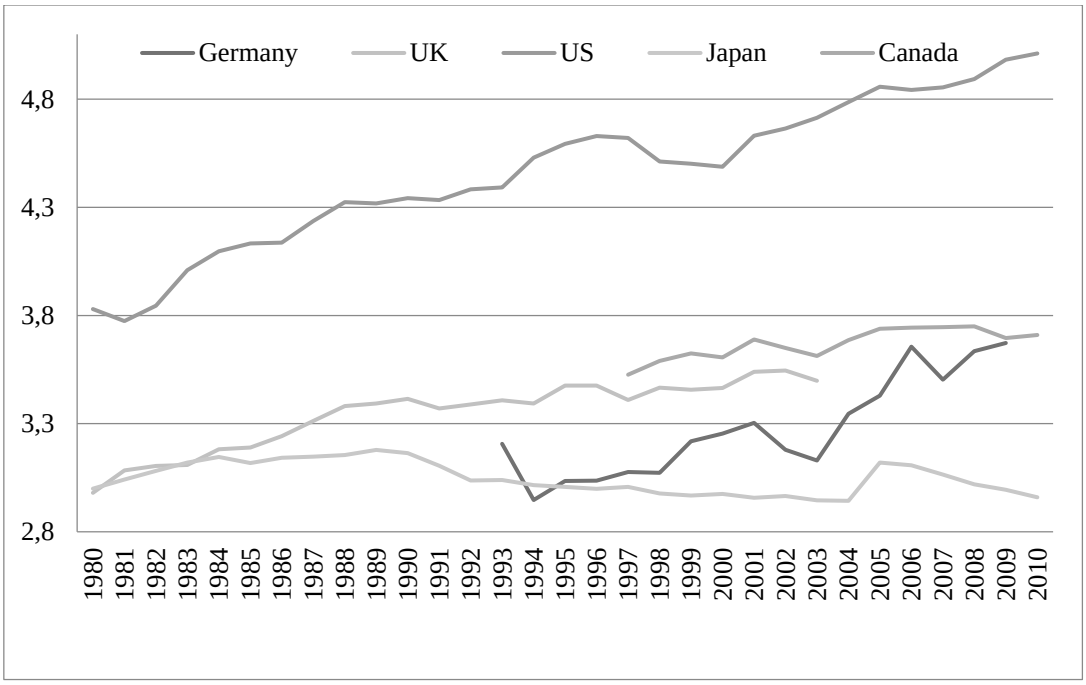


Figure 4.1: Income ratios P90/P10 for the largest 5 advanced economies 1980-2010 (OECD, 2011)[30]

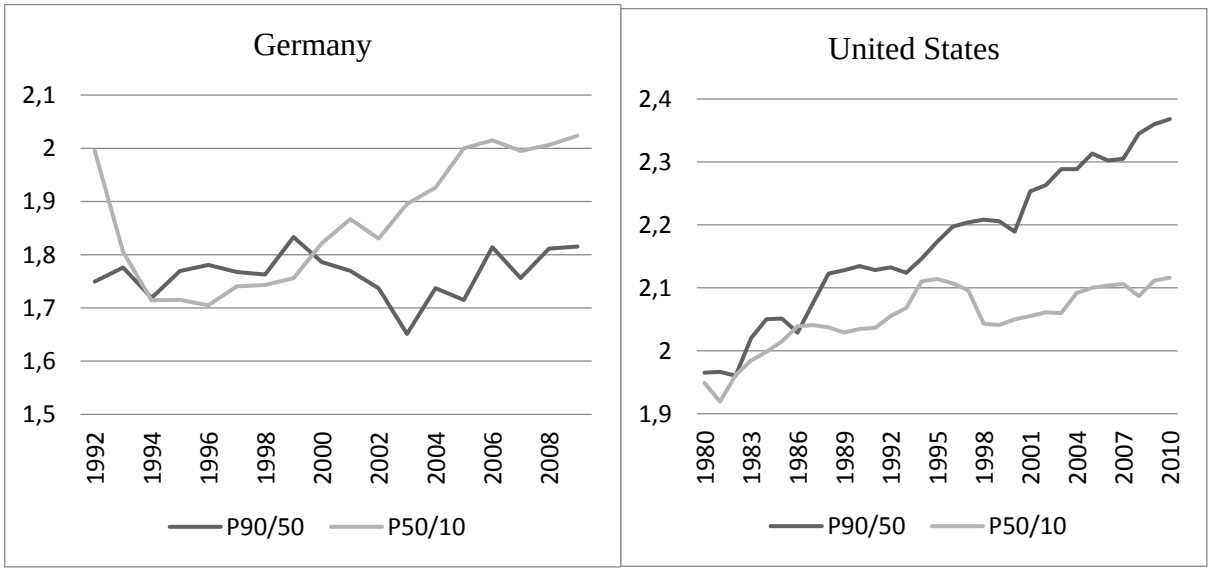


Figure 4.2a: Income ratios P90/P50 and P50/P10 for the largest advanced economies 1980-2010 (OECD, 2011)[31]

[30] Gross earnings for full-time employees. GER & JAP: monthly earnings; US, UK & CAN: weekly earnings.
[31] Gross earnings for full-time employees. GER & JAP: monthly earnings; US, UK & CAN: weekly earnings.

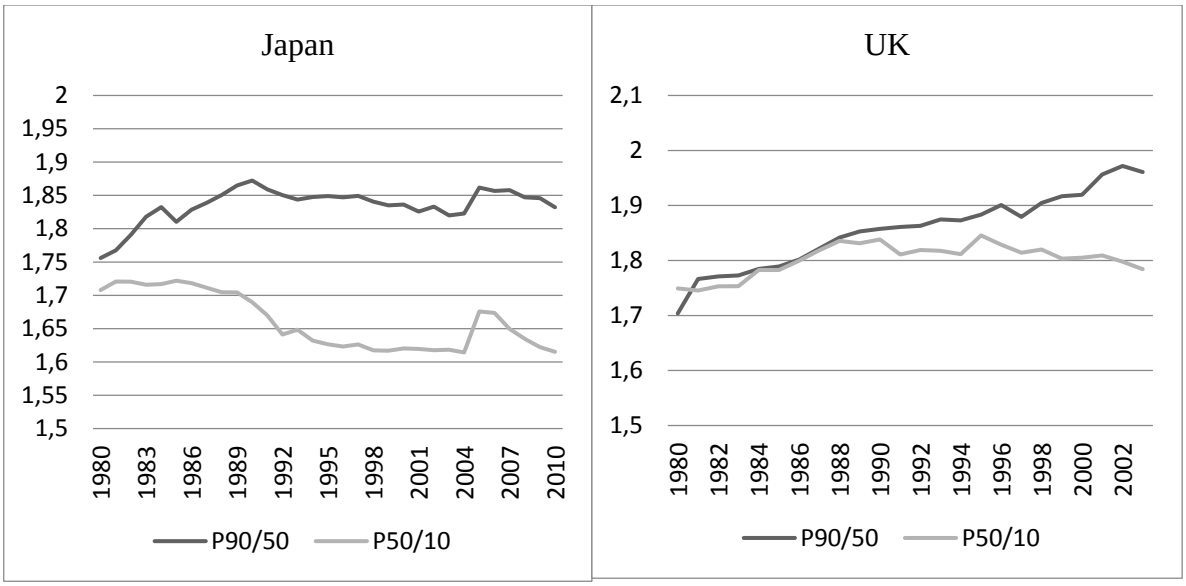


Figure 4.2b: Income ratios P90/P50 and P50/P10 for the largest advanced economies 1980-2010 (OECD, 2011)[32]

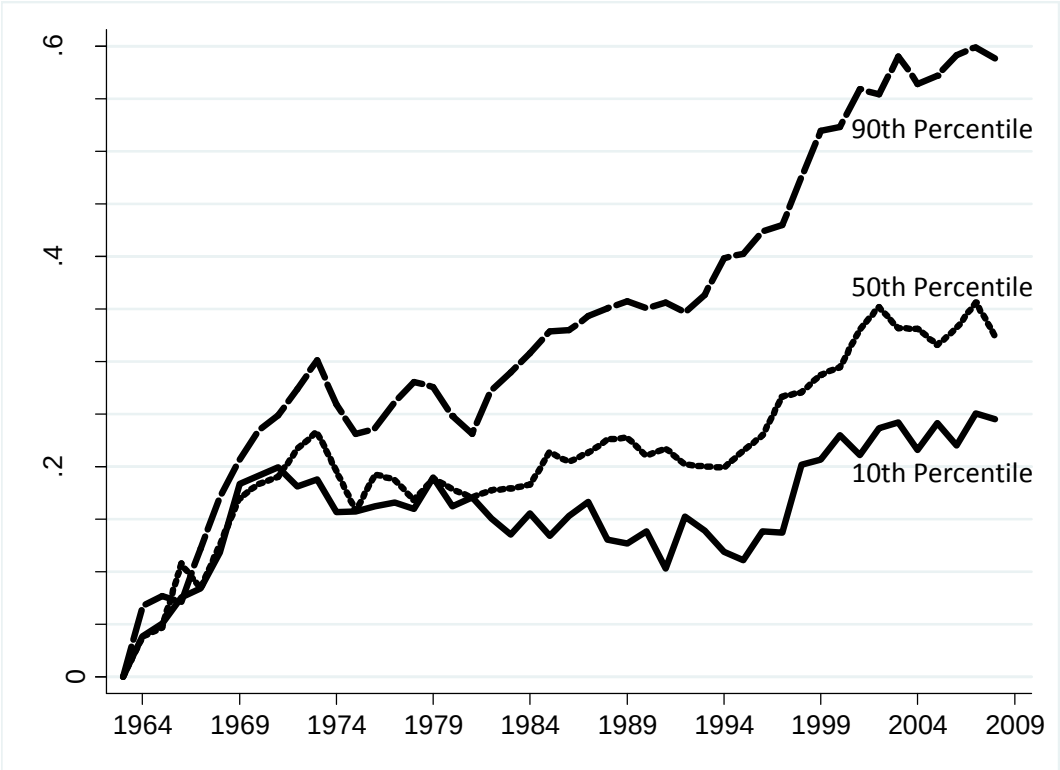


Figure 4.3 Accumulated wage growth for US full-time full-year workers[33]

[32] Gross earnings for full-time employees. GER & JAP: monthly earnings; US, UK & CAN: weekly earnings.
[33] Based on Acemoglu and Autor (2011: 1064).

Figure 4.3 now turns from relative inclusiveness by comparing income groups to a comparison within the accumulated growth process. This is a serious concern because we not just ask how groups could relatively participate, i.e. even in a polarizing economy groups relatively falling behind can still gain from the process if they are absolutely better off over time. Hence we ask now if there are winners and losers in the absolute sense.

While in the 1960s and early 1970s all groups clearly participated and hence growth was inclusive, the picture changed from early 1970s. As we can see, since early 1970s in particular the 10th and somehow also the 50th percentile could hardly increase their real weekly earnings. When looking at hourly wages and taking also part-time and part-year workers into consideration, downward movements in the 10th percentile become even more pronounced The highest 10 percentiles however clearly gained. Hence, since the early 1970s a large share of US labor was only weekly included in the average absolute income gains. However, with this observation it becomes clear that inclusiveness is not an unambiguous concept. How can we evaluate the growth of the lowest income group? Is it a positive sign of inclusiveness that the lowest incomes do not stagnate or lose even more? It could be if there were not a second fact.

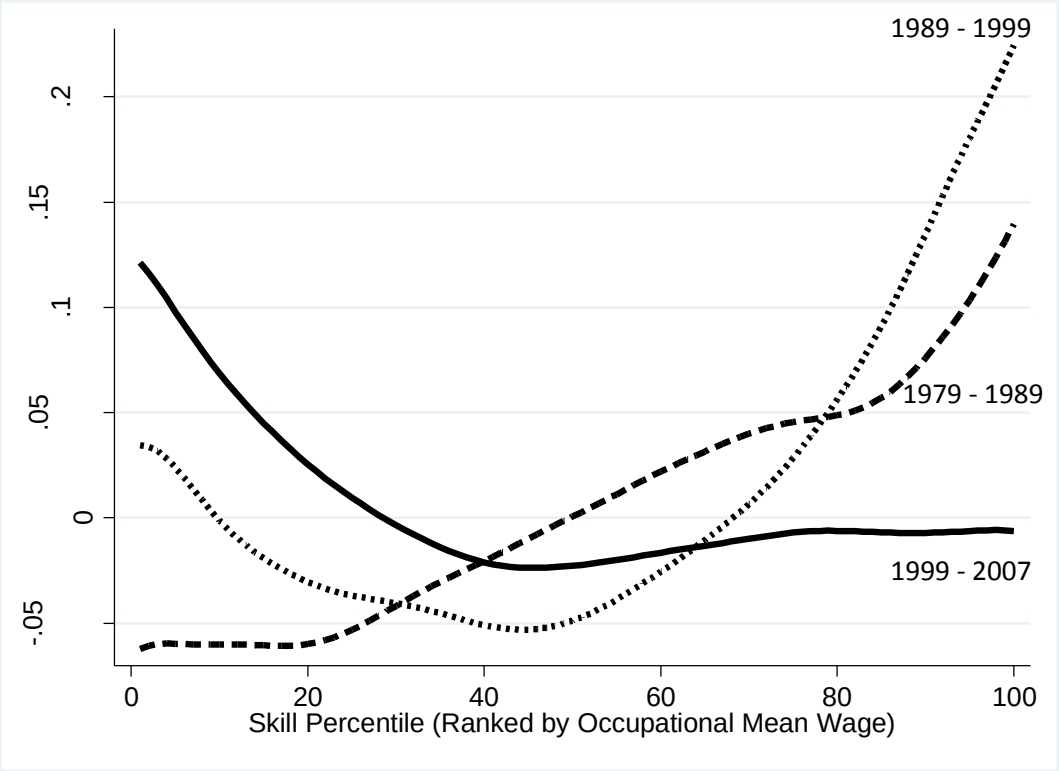


Figure 4.4: Pattern of job growth in the US, three decades 1979 - 2007[34]

The second dimension considers job growth. We can ask in which occupations do we see an increasing or decreasing number of jobs? Are the new jobs in occupations in higher, middle or lower wage activities. In other words, do more people enjoy higher income due to an increase in higher income jobs, or do we see a shift towards more low paid jobs? Figure 3.4 presents details about the long term development for the U.S. during the last three decades. The broad picture indicates that the three decades show a very different pattern of job growth.

[34] Based on Acemoglu and Autor (2011: 1071).

The figure shows that during the 1980s the experience was that the number of jobs grew the more the higher the skill, where the skill level is approximated by the wage level. Job growth was positively related to the skill level of the job. As the skill level relates to the wage level of an occupation middle and high income/skill jobs expanded broadly. Inclusiveness via education was made possible for a broad share of the population.

This picture changed during the 1990s. For this decade we can see that job growth continued for the top three skill deciles and also that growth was larger the higher the skill level. Similarly, the job share for the bottom decile gained. However, they gained less than the top three deciles. In contrast and most important is the observation that the six skill deciles in between realized a substantial loss in their employment share. The middle skill jobs started to disappear.

Changes that occurred during the 1990s became even more pronounced during the 2000s. During this decade growth in job share was only to be found in the bottom three skill deciles. More middle skill jobs were lost and even the high skill jobs' share stagnated. Hence, after analyzing this structure of jobs we can see evidence of job polarization. The share of high income jobs is significantly increasing and so does the share of low skill jobs. The share of middle skill jobs, however, declines. Figure 4.4 shows this for the US and table 4.1 identifies the respective profession and jobs and describes a similar finding for a number of European countries (Goos et al., 2014).

Occupations ranked by mean European wage	ISCO code	Average employment share in 1993 (in percent) (1)	Percentage point change 1993-2010 (2)
High-paying occupations		31.67	5.62
Corporate managers	12	5.65	0.59
Physical, mathematical, and engineering professionals	21	2.93	1.36
Life science and health professionals	22	2.01	0.57
Other professionals	24	2.79	1.38
Managers of small enterprises	13	4.16	0.17
Physical, mathematical, and engineering associate professionals	31	4.44	0.21
Other associate professionals	34	7.24	0.79
Life science and health associate professionals	32	2.45	0.55
Middling occupations		46.75	- 9.27
Stationary plant and related operators	81	1.70	- 0.25
Metal. machinery, and related trade work	72	8.78	- 2.08
Drivers and mobile plant operators	83	5.03	- 0.48
Office clerks	41	10.60	- 2.06
Precision, handicraft, craft printing, and related trade workers	73	1.45	- 0.54
Extraction and building trades workers	71	7.35	- 0.64
Customer service clerks	42	2.13	0.06
Machine operators and assembles	82	5.99	- 1.63
Other craft and related trade workers	74	3.72	- 1.66
Low-paying occupations		21.56	3.65
Labors in mining, construction, manufacturing, and transport	93	4.26	- 0.55
Personal and protective service workers	51	6.86	2.36
Models, salespersons, and demonstrations	52	6.06	- 0.11
Sales and service elementary occupations	91	4.38	1.95

Table 4.1: Level and changes in the shares of hours worked 1993-2010[35]

Conclusively we find that around one third of the labor force is clearly improving their absolute and relative income position, while one other third of middle income workers is relatively losing

[35] Based on Goos, et al. (2014:2512).

and stagnating in absolute terms. The lowest quarter of incomes is relatively losing towards the highest, but converging towards the middle group.

If this tendency continues the middle income group will disappear in favor of a gaining high income group of about 30 percent while all other income groups converge and become a large low income group with stagnating income dynamics. Therefore, the majority of the labor force is not included in the major beneficial effects of the growth process. One third of occupations can realize substantial relative and absolute income growth while the two other thirds do not. This holds true not only for the US, but for many other advanced economies (figure 4.5). Other indicators may be also used to shed light on the situation and to find out if we have inclusive growth. Considering other measures of income inequality like, e.g., the Gini coefficient the picture shows that for almost all advanced economies we see an increase in measures of inequality (OECD, 2011).

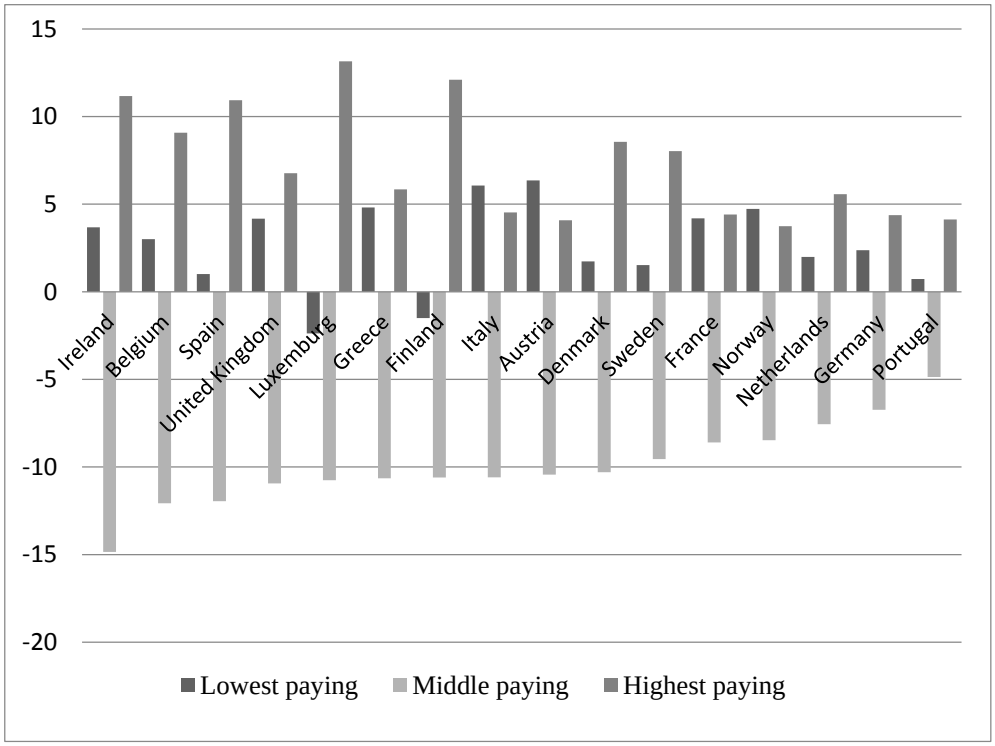


Figure 4.5: Pattern of job growth, international comparison, 1993-2010[36]

Further, it is also insightful to look at the very top end of the income distribution. Once we look at the highest income groups it becomes apparent that the highest 5 percentiles and in particular the richest percentile are the really gaining groups. Gains are thus very much concentrated in the very richest segments (figure 4.6).

[36] Based on Table 2 in Goos et al. (2014) Occupational employment pooled within each country. Lowest-/Middle-/Highest paying occupations are grouped according to the mean European occupational wage.

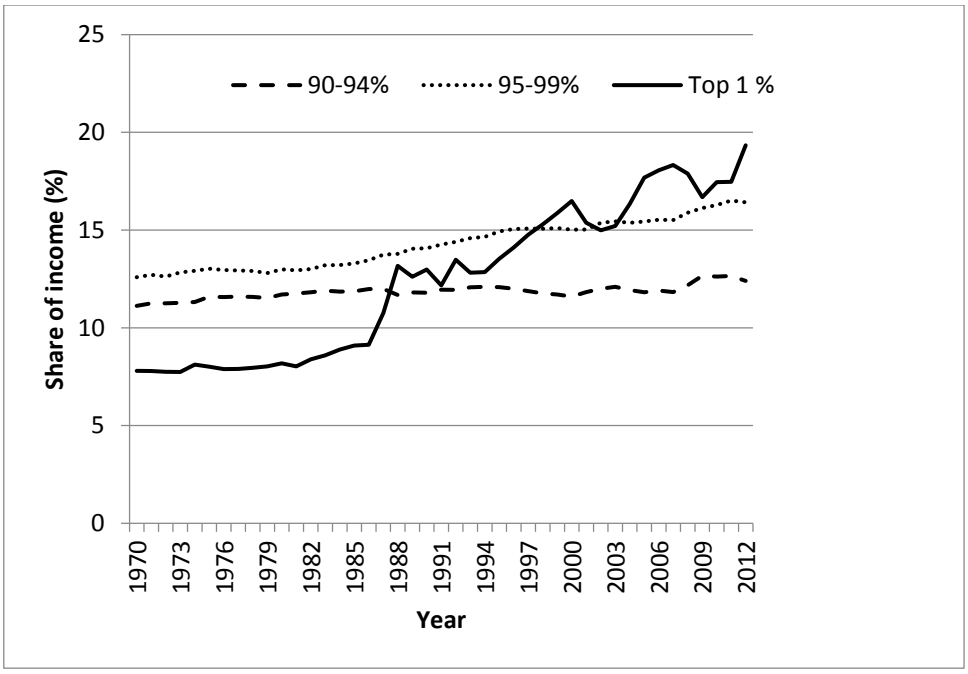


Figure 4.6: Top income group development for the U.S. [37]

Comparing countries and considering international developments we can see in figure 4.7 that the top income group (top 1 percentile) relatively gained in the share of total income. With respect to the top income group it seems that with the exception of Finland the Anglo- American market economy model has mostly favored this group.

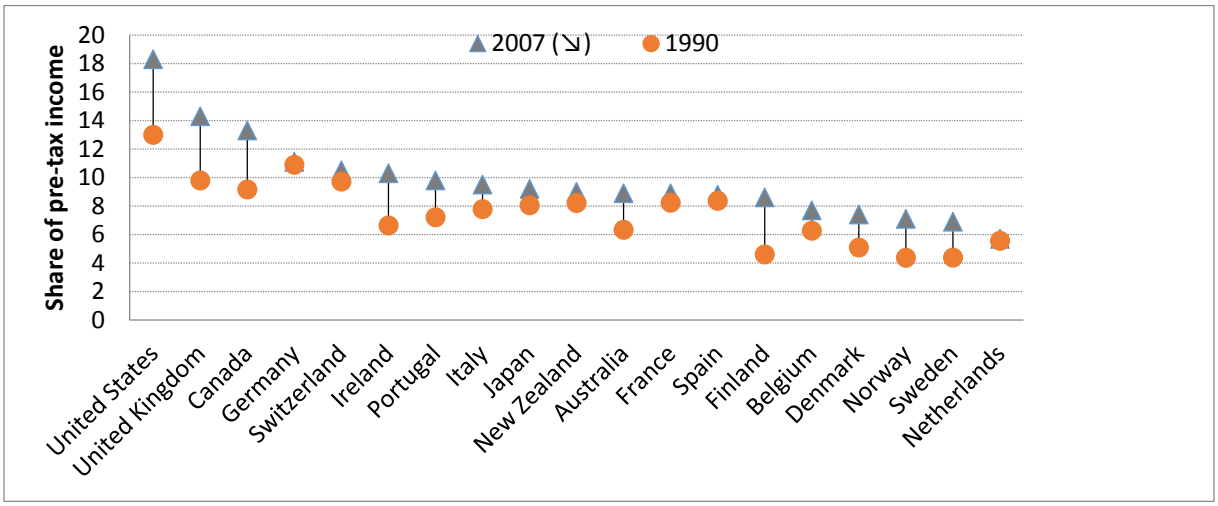


Figure 4.7: Income share of top 1% income group, International comparison 1990 – 2007[38]

Hence, summing up all these indicators i) the growth process in the advanced economies could not improve conditions for a large fraction of population. ii) The income gap between about two thirds of the wage earners and the upper one third increased strongly. iii) The process

[37] Based on Alvaredo et al. (2014). Income definition: Pre-tax income.
[38] Based on OECD (2011). Income definition: Pre-tax income.

favored in particular the 30 top percentiles of incomes. iv) Considering more details we can see that the top percentiles (five and one) gained by far the most.

4.2 What causes non-inclusiveness in advanced economies?

To discuss the driving forces of increasing income inequality we use the framework presented in section 2. Most relevant are (i) the hypothesis of skill-biased technological change (SBTC), (ii) the implications of the factor price equalization theorem; (iii) Piketty's argument that there is a secular trend in the labor to capital income ratio favoring capital, and (iv) inequality due to the nature of growth of agglomerations.

4.2.1 Effects of skill-biased technological change

When new technologies raise the relative demand for higher skilled workers, changes in the wage structure create winners and losers (Goldin and Katz, 2009: 320-323). The notion of skill-biased technological change has been discussed as a general theoretical phenomenon in another section (section 3.1). Therefore, here we come back in this discussion to some of the major empirical findings with respect to the effects on income disparity. The mechanism of SBTC suggests that biased technological change and capital labor complementarity drives the demand for high skilled labor and leads to a decline in demand for lower skill levels. As a result, even if there are education efforts and the supply of well-educated labor increases, the effect of the shifting demand in favor of high skills dominates and relative wages for skilled labor go up.[39]

Much of the literature of the 20th century finds that SBTC in the broad sense, including capital deepening and organizational changes, is a main driving force behind the increase in the relative demand for more skilled and more educated workers.[40] This is often found to be in line with direct evidence of capital-skill and technology-skill complementarity and with increases in the relative demand for skill within industries and within plants (Katz and Autor, 1999).

While the initial discussion has tended to focus on the shifts in relative job demand, i.e. a focus on low versus high skill-characteristics of jobs, the more recent discussion indicates that we observe a polarization of jobs with respect to skills.[41] Identification of polarization requires to look at three skill levels, low, middle and high skills. In addition to an identification of job polarization, also the distinction between routine versus non-routine jobs that has been mentioned earlier has become relevant (Autor et al., 2003). This differentiation is related to skill characteristics, because often non-routine jobs can be supposed to need higher skills than routine jobs. However, in this discussion the explanation of job polarization is that technological change is biased towards replacing labor in routine tasks, leading to a decrease in the demand for the middle skill segment relative to the high-skill and low-skill segments. The bias in terms of routine tasks leads to a shift in the structure of employment both within-

[39] See surveys by Katz and Autor (1999), Goldin and Katz (2008, 2009) and Acemoglu and Autor (2011).
[40] See Katz and Autor (1999) for a survey.
[41] For the US see Autor et al. (2003); Autor et al. (2006, 2008); Autor and Dorn (2013); for Germany: Spitz-Oener (2006); Dustmann et al. (2009); for the United Kingdom: Goos and Manning (2007); for other Western countries: Goos et al. (2014), Michaels et al. (2014); and Van Reenen (2011).

industries and between industries (Goos et al., 2014: 2509-2510). Thus as an overall result there seems not much doubt that - among other factors - skill biased technological change created - at least until the 2000s – a strong growth for high skilled jobs. This growth of high skilled jobs however, ended with the turn of the century, at least in the U.S:

Beside the development of the structure of job characteristics it is also important to discuss the evolution of the wage and income structure. Does the skill biased technological change also cause the increasing income differential? Strong growth in the relative demand for high-skill workers, in combination with fluctuations in the growth of relative skill supplies, can explain major aspects in the evolution of educational wage differentials in the U.S., such as the rise in the college premium from 1980 to 2005 (Goldin and Katz, 2009). The distribution of the wage structure very much reflects the distribution of the change in job structure. Even if lower qualification levels could recently stabilize income, only high qualifications namely college and higher education levels could benefit over the long term. That is, low and middle skills not only had to face increasing job market competition, in this declining job market they also reduced their income opportunities as can be seen in figure 4.8.

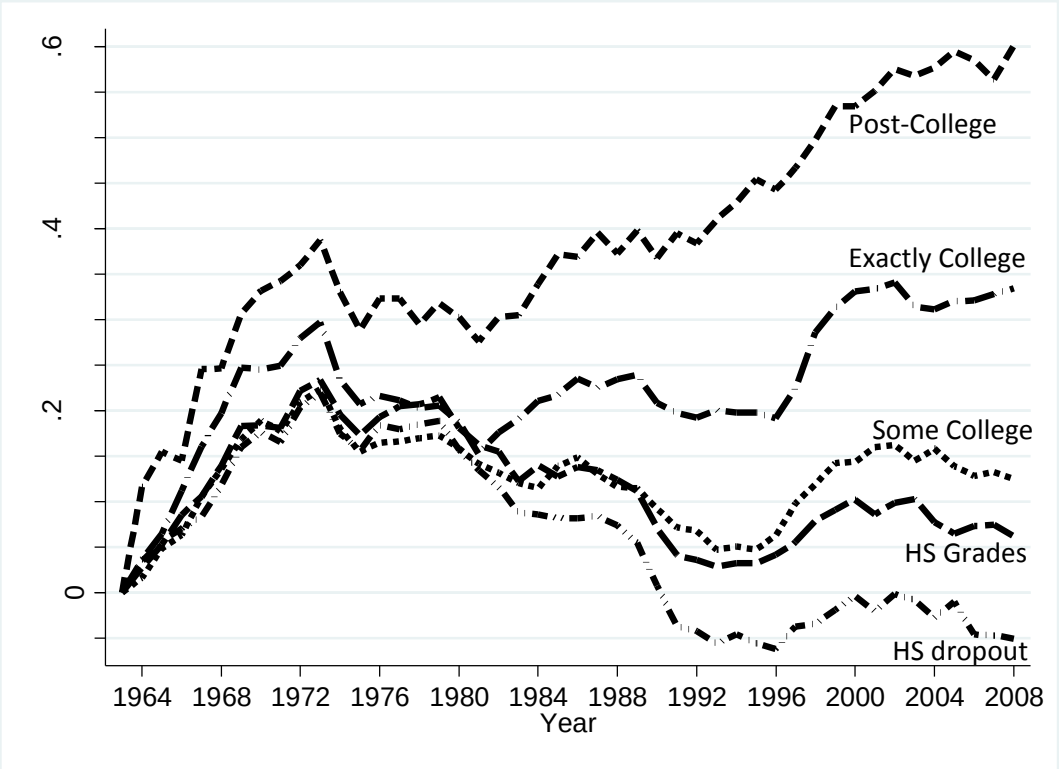


Figure 4.8: Change in log income for various skill groups in the U.S.[42]

While during the 1960s all skill levels in the USA benefitted from growth the early 1970s mark a turning point. Since then only college and upper education could further increase income growth rates while all other education groups suffered from reduced income growth. High school drop outs even had to realize an absolute decline (relative to the beginning of the sample period) starting at the beginning of the 60s. The increasing competition in a shrinking market together with job up- and down-grading mechanism could drive wages at both sides of wage

[42] Based on Acemoglu and Autor (2011).

distribution. An excess demand in particular for high skills led to highest income growth in this market segment. The fading demand for middle level qualification however, caused only stagnating wages for middle qualifications. [43]

What is the implication of both trends? Most important, if as shown in the figure 4.4 for the 2000s the low wage sector remains the only growing sector and middle income will further stagnate, we may see a convergence of the low and classic middle income sector at a wage level between the current low and medium income level. These groups seem to count for about two thirds of the labor force. The other group seems to stabilize in size at a one third level.

However, this may change once the next technology push is introduced. With the next phase of industry production described by labels like "advanced manufacturing" or "industrial internet" or "industry 4.0" it seems likely that the lower end of high skill jobs are affected. If networks of interconnected machine systems control and regulate themselves and the related market interactions are automated through data analysis jobs, the middle management will break away. Disposition management, for example, is likely to be substituted by "smart production". Similar, if even engineering activities can be substituted by smart software programs such high skill processes are declining and will lead – as observed earlier – to either downgraded or upgraded other jobs. Respective wage adjustments tend to follow.

While this broad picture may be the result of sorting mechanisms associated with technology conditions like SBTC or RBTC the top end of the income distribution does not seem to be connected to technologies, skill or education.

4.2.2 Globalization and implications of the factor price equalization theorem

The impact of globalization is recognized as another major cause for the observable polarization of jobs and increasing inequality (e.g. Krugman, 2008; Alderson and Nielsen, 2002). As discussed in the above section 3.2 global value networks can define a large number of nodes and allocate these nodes according to comparative advantages. Hence, we find nodes which are skill, knowledge and capital intensive and others which have a high labor (low-skill) intensity. When organizing these networks according to comparative advantages labor intensive processes are allocated to labor abundant countries. Thus labor intensive and often low- or medium skill requiring processes are produced in developing countries with extremely low wages leading to a fall in prices for these processes. Applying the *Stolper-Samuelson Therorem* and the *Factor Price Equalization Theorem* trade not only links goods markets or markets for tasks, trade also globally links labor markets.

Low wages for middle and higher skills in developing countries put pressure on wages and jobs of middle and lower skilled workers in advanced economies. Goods and tasks with a high skill and capital intensity however are the goods with comparative advantages in advanced economies and hence the high skill segment will gain. The mechanics of the factor price equalization theorem will tend to equalize factor compensations for factors producing in competing nodes. Most physical production in industrial networks is done at a skill level of

[43] While the majority of contributions is convinced that SBTC is an important explanation Lemieux (2006) does not find evidence for of a strong increase in the demand for skill that is to be attributed to SBTC.

completed secondary education. Hence, these market segments link-up. Labor from the classical blue collar working middle class in advanced economies now produces components and tasks in nodes which are competing with nodes in emerging economies like China. Hence jobs for low and medium skilled labor in the advanced economies are under pressure. These jobs had to face an increasing competition in the global markets. The result of this structure of competition is consistent with the observed facts on non-inclusive growth and increasing income disparity in advanced economies. Even if this narrative is plausible and consistent with the facts it is still interesting if this mechanism is an important effect compared to the direct skill-biased technology effects. Maybe this potential mechanism is just one among many. This empirical question is particular interesting because the answer will have clear implications on trade policies.

Some authors have argued that international trade has been a cause of "de-industrialization" and hence trade is regarded to be at least partially responsible for a substantial loss of manufacturing low- and medium skill jobs (Wood, 1994; 1995; 1998). Increasing international competition could also have additional, more indirect effects. International integration of goods markets means that it is impossible to insulate domestic labor markets and hence international integration causes unfavorable effects for the low skill labor market segment (Borjas and Ramey, 1995).

However, results of this discussion are not conclusive.[44] Some authors suggest that the introduction of new technology appears to be the more important factor behind relative demand shifts favoring the more-skilled. They point to the strong positive correlation between the rate of skill-upgrading and indicators of technological change (e.g. Katz and Autor, 1999: 1539). Others see at least a significant effect of internationalization and global sourcing activities. International trade, and in particular outsourcing, are considered to contribute to an increase in the wage gap between skilled and unskilled workers and overall skill-upgrading. *"While there is abundant evidence of skill-biased technological change, it also appears that international trade, in the form of foreign outsourcing, contributes to skill upgrading and increases in the skilled-unskilled wage gap."* (Feenstra and Hanson, 2001: 46)

However, for the discussion here it seems important that both mechanisms are two dimensions of technology and know-how generation and transmission. First, there is the invention of technologies in the advanced economies, and second there is a transfer of technologies and knowledge towards developing economies which enables these economies to participate in international value networks and link-up to the advanced world. Both dimensions seem to play an important role for inclusiveness.

Hence, a framework in which skills and tasks are treated as distinct concepts, and in which tasks can be outsourced or offshored can help to understand major aspects that are important in the discussion of technological change and the inclusiveness of growth. In particular, it elucidates the polarization of earnings distributions that go along with a "*convexifcation*" in the returns to schooling. Furthermore, it sheds light on the introduction of new technologies and offshoring

[44] Slaughter (1998) provides review of this discussion, or Harrison and McMillan (2011) for a more nuanced view on the issue.

possibilities that seem to directly substitute tasks that used to be performed by middle-skill workers with capital in the form of machines (Acemoglu and Autor, 2011: 1157).

4.2.3 The dominance of capital accumulation and the Piketty results

Recently the collection of historic data on income and wealth growth and even more on distribution by Piketty (2014) is also a closely related issue needing discussion in this contribution. Reflected in long-term data, as interpreted by Piketty, capitalism leads to an inherent economic divergence between capital and labor income. Piketty uses two elements for his reasoning. The first element is the observation that the capital coefficient $\beta=K/Y$ is u-shaped as a secular phenomenon. The second element is the definition of the income share of capital $\alpha=rK/Y=r\beta$. For this element he states that the income share of capital will continuously increase if the return on capital exceeds the GDP growth rate, $r > g$.

However, this result is somewhat ad hoc, because to obtain this condition a number of rather strong implicit assumptions have to be made.[45] The economic reasoning he suggests depends on two positive feedback loops (i) as the share of capital income (α) increases, not only do capital owners become richer, if as long as they do not consume their entire return from capital, more will be reinvested in even more capital, and thus (ii) increasing saving further fosters this process. Increasing β drives α and increasing α drives β. Therefore, his major relation to look at is to compare the return on capital with the GDP growth rate. And as empirical evidence suggests that the return on capital is higher than the GDP growth rate he predicts a secular relative gain for capital income compared to labor income. However, this reasoning misses many (hidden) assumptions about mechanisms in his interpretation. Furthermore, there are a number of additional reasons why this interpretation is oversimplifying.

First, considering growth theory, the golden rule of growth theory suggests that a maximum consumption path should follow the golden rule $r = g$. If r is larger than g we should save more in order to establish a higher consumption trajectory. Even more, introducing not only a simple consumption rule but an inter-temporal welfare function, the fundamental condition for an optimal growth trajectory is given by the Ramsey Rule. According to the Ramsey Rule optimal growth is described by $g = (r - \rho)/\eta$ under a large set of conditions. Thus, according to this condition and depending on inter-temporal preferences an economy can easily develop in an optimal way if the growth rate g is smaller than the return on capital r.[46] In this light the empirical regularity of r > g may still indicate optimal growth and a negative interpretation may thus be misleading. Therefore, checking the r > g as an empirically crucial condition is at least misleading for obtaining a good understanding of the observed phenomenon.

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[45] Just taking the formal time derivative on the definition of the income share of capital results in $\dot{\alpha} = \beta\dot{r} + r\dot{\beta} = \beta\dot{r} + r\left(\frac{\dot{K}}{Y} - K\frac{\dot{Y}}{Y^2}\right)$. In order to arrive at the Piketty inequality condition we need to assume that purely capital income contributes to capital accumulation with the savings rate s^K , such that $\dot{K} = s^K rK$. This leads to $\dot{\alpha} = \beta\dot{r} + r(s^K r\beta - g\beta) = \beta\dot{r} + r\beta(s^K r - g)$. Eventually, only for $\dot{r} = 0$ and $s^K = 1$ condition $r > g$ becomes the only relevant condition for determining the change of α as being continuously growing over time: $\dot{\alpha} = r\beta(r - g) > 0$.

[46] Here ρ is the time preference rate and η elasticity of intertemporal substitutions.

Second, as we know from section 3.1 above, we should be aware of production technologies and supply and demand conditions on factor markets when discussing the direction of disparities. Factor demand and supply growth, factor rewards together with technology characteristics like factor substitutability must be expected to be crucial for the primary distribution. Hence, considering rather detailed and complex interactions of a different kind of components may lead to a better understanding of the suggested phenomenon of a secular trend in income distribution. Therefore, this may be more fruitful than the suggestion of a natural law where in reality fundamental conditions worked towards one direction for one period before changing to work towards another direction during another period.

The most important driving force of these processes – almost by definition – is technological change. As technological change is - as already discussed - biased towards one or the other factor, it seems worth to have a closer look at the directions of technological change. This exactly leads us back to the discussion of section 4.2.1 and 4.2.2. For a more sophisticated theory we may turn back to the model by e.g. Acemoglu and Autor (2011). However, in a much more simple way we can also check for implications of standard theories on the primary distribution. The question of the primary distribution in growth processes can be clearly answered by e.g. standard neoclassical growth theory. Taking neoclassical theory as a theoretical benchmark we can define a measure of income distribution as the total capital income over total labor income.

$$\delta = \frac{rK}{wL}$$

With factor rewards determined by marginal productivities we can derive that labor augmenting technological change will lead to a path of distribution which may lead towards all kinds of directions. Taking the time derivative of δ and assuming a neoclassical production function we obtain

$$\frac{\dot{\delta}}{\delta} = \left(1 - \frac{1}{\sigma_{L,K}}\right)\frac{\dot{k}}{k} - \frac{\dot{A}}{A}.$$

During capital deepening and an increasing capital intensity the development of the distribution depends on the elasticity of substitution and the speed of technological change, $\dot{A}/A$

Which factor, labor or capital benefits more from the growth process driven by technological change and accumulation? Hence, even in this most simple model we see that a technological parameter such as the elasticity of substitution is most important and it is unrealistic to expect that such a parameter does not change over time. Therefore, if labor can be easily substituted with capital an increasing relative capital intensity during the adjustment towards steady state will led interest rates [$\sigma_{L,K}$ >1] only reduce less than proportionate. Distribution may change in favor of capital. This would be also consistent with the capital skill complementarity hypothesis and labor augmenting technological progress for low skills. However, if the elasticity of substitution is less than one the opposite could happen.

4.2.4 Local immobile resources and urban land prices

The data collected by Piketty and others reveal another interesting fact which as been so far not sufficiently considered. When he describes the long term wealth components he divides wealth into the value of land, other domestic capital (productive capital), net-foreign capital and domestic housing. When looking at the development of the shares of these elements of capital on total wealth in figure 4.9 it is interesting that most prominent for France and the UK but also for Germany and a bit less for the US housing plays an extraordinary role. In these countries housing is not only the driving wealth component, it also makes up more than half of total wealth. In the context of the discussion of technological change and inclusiveness there seems so far no direct connection to the local housing sector. Why then is this fact most important and most interesting? Why is it most interesting to look at the housing and real estate sector even if we talk about technological innovations driven by developments in the industry sector?

The reason is simple and identifies the core of the notion of inclusiveness. Even if - no doubt - productivity growth is most often generated in the industry and service sectors, and even if we also see these sectors benefitting from technological change, large benefits of technological change and productivity growth spread through market interdependencies. Hence, at the end of this process the benefits and even more rents may spread throughout the system even to entities which had never to do with the introduction of a new technology.

What does that mean? Benefits and rents associated with innovations and most often simultaneously generated are distributed according to rules other than “the inventing sector gets all”. Today we have to understand that technological change introduced in a region will cause benefits for various groups no matter if directly connected to the original introduction of technological change or not.

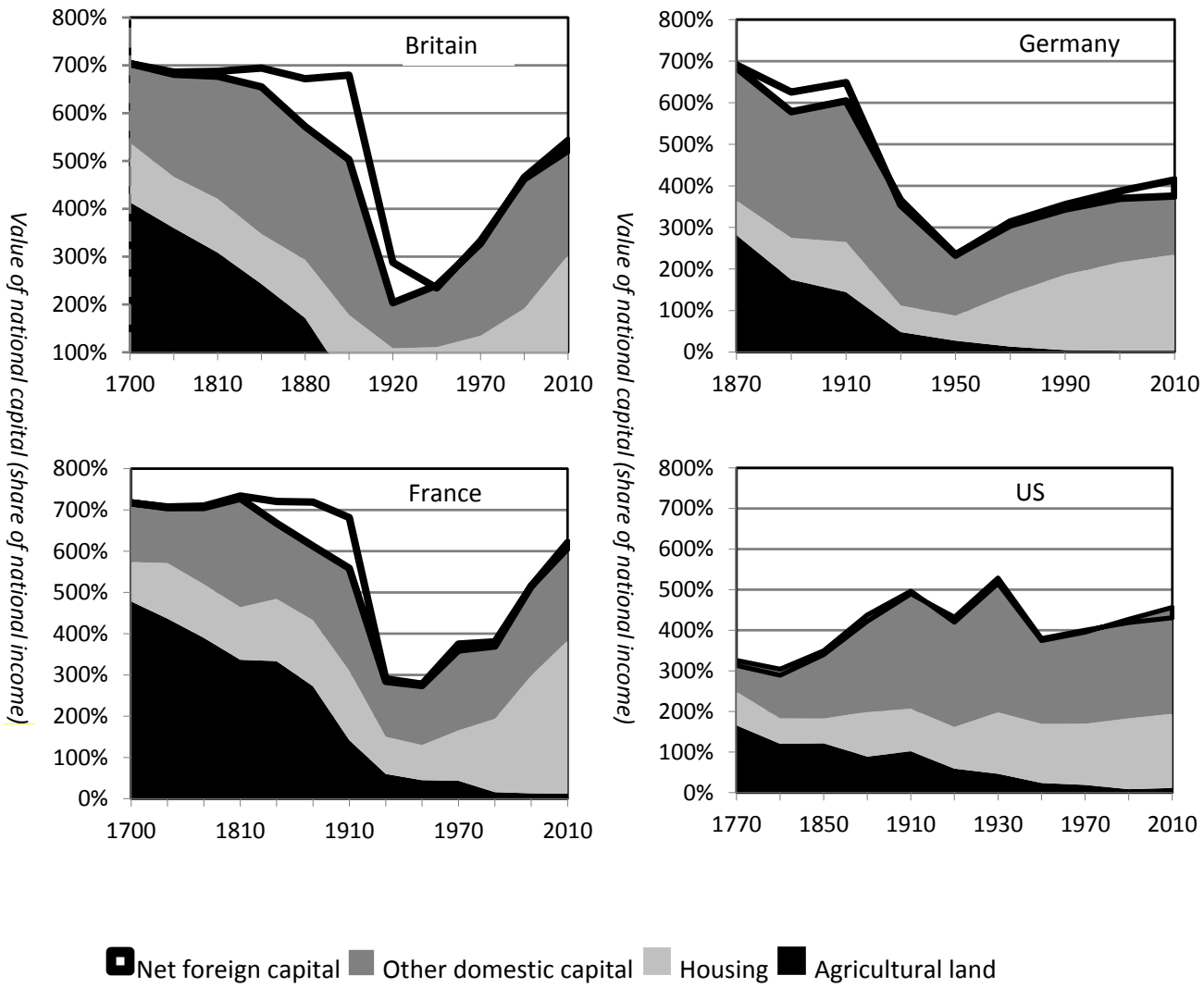

Figure 4.9: Secular development of wealth in relation to income[47]

The reallocation process accompanying technological change is illuminated in the New Economic Geography.[48] Technological change leads to endogenous agglomerations and concentration of economic activities.[49] Economic concentration and agglomeration, however, cause positive and negative effects. Growth promoting effects are associated with scale economies and positive externalities while aggravating effects are associated with congestions costs. International and regional integration through trade, capital mobility and migration can promote such agglomerating processes further.[50]

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[47] Piketty 2014, figure 3.1, figure 3.2, figure 4.1 and figure 4.6.

[48] Contributions from Krugman (1991a, 1991b, 1993), Krugman and Venables, (1995) and Fujita and Thisse (2002) characterize this approach.

[49] Examples for such models are Walz (1996) who models linkages between intermediate and final good producers can which lead to a clustering of production and innovation activities in one region, Eaton & Eckstein (1997) model urbanization and growth as driven by the accumulation of human capital, or Martin and Ottaviano (2001) who suggest a mutual self-reinforcing process of endogenous growth and agglomeration by a similar mechanism as discussed in the endogenous growth models of the Romer (1990)- and Helpman (1992)- type.

[50] Eaton & Kortum (2001) apply a quality ladder model with endogenous innovation and trade to analyze the effect of lower geographic barriers. Baldwin and Forslid (2000a) studies the stabilizing effects of

Furthermore, there are also allocation and distribution effects of technological change in such agglomerating centers. With a model of endogenous formation of regions, international trade as the connection to international markets, mobile factors between regions and locally immobile factors, such distribution effects can be determined (Gries and Naudé, 2008). In such a model it can be illustrated that technological change in an innovative region will make that region more competitive in global markets. Improved competitiveness causes an increase in average income and hence technological change is positive for the inventing region as a first effect. However, how are the benefits distributed? Which are the factors of production that gain most from the innovation? The answer is surprising. Neither the inventor that generated technological change will gain much; nor will the mobile resource needed for the innovating sector's expansion significantly gain. Mobile resources moving in from other regions enable the region to broadly expand and prosper due to the improved international competitiveness.

The gaining factor, however, is the local immobile factor. With higher competitiveness production can expand. For an expansion of the more competitive sector this sector needs more factors of production. There is an excess demand both for mobile and local immobile resources and the reward for both factors tend to rise. However, rewards for the mobile factor will not significantly rise in the successful region because the immigration of additional resources will elastically supply the factor quantity needed for the economic expansion. This is different for the immobile factor. The economic expansion in the agglomerating region and the excess demand of the immobile factor will drive the reward for the immobile factor as the additional supply is limited. As long as there is not an extremely high elasticity of supply the high demand and limited additional supply drives factor prices for the immobile factor in the agglomerating region and allocates rents from technological change through the market mechanism to this immobile factor.

What is the local immobile factor of production? Most obvious, it is urban land. Moving from the abstract discussion to a more simple narrative the mechanism is easily described. Innovations in dynamic successful firms often located in a particular region allow for this sector to expand to international markets. The expansion of these firms or sectors requires more resources. Some resources like labor and human capital are mobile. They are attracted by such successful firms and move from other regions to the agglomerating region which often is an urban center. However, as long as the external supply from other regions is highly elastic wages do not need to rise substantially. In contrast to this moderate rise in wages stands the strong push in prices for urban land. The elasticity of supply of urban land is low as a result of no, low or late reactions of urban planners to organize sufficient supply, and because of long planning and developing and construction times. However, the result is clear. Urban landowners finally profit most because they own the resource which cannot be substituted easily. Therefore, even if they had nothing to do with the innovations that generated higher productivity in the first instance, rent is channeled to them through rising prices of developed land.[51] This mechanism

integration and Baldwin and Forslid (2000b) studies growth and trade including financial intermediation. Baldwin and Martin (2004) illustrate the importance of capital mobility. Migration as driving force of agglomeration was suggested by Walz (1996), Baldwin and Forslid (2000a), Black and Henderson (1999), Fujita and Thisse (2002, ch. 11) and Kondo (2004).

[51] See e.g. Adair et al, (1999) and Wang et al., (2011) for the effect of economic openness on real estate prices.

holds under perfect competition and becomes even more extreme with markets frictions and additional rents. This mechanism can be observed in large urban centers of advanced economies and emerging markets. Urban land is expensive and enjoyed a rising relative price during the last 70 years after World War II. Figure 4.10 shows this hypothesis for the examples of the US, Japan, Germany, the UK, and France.

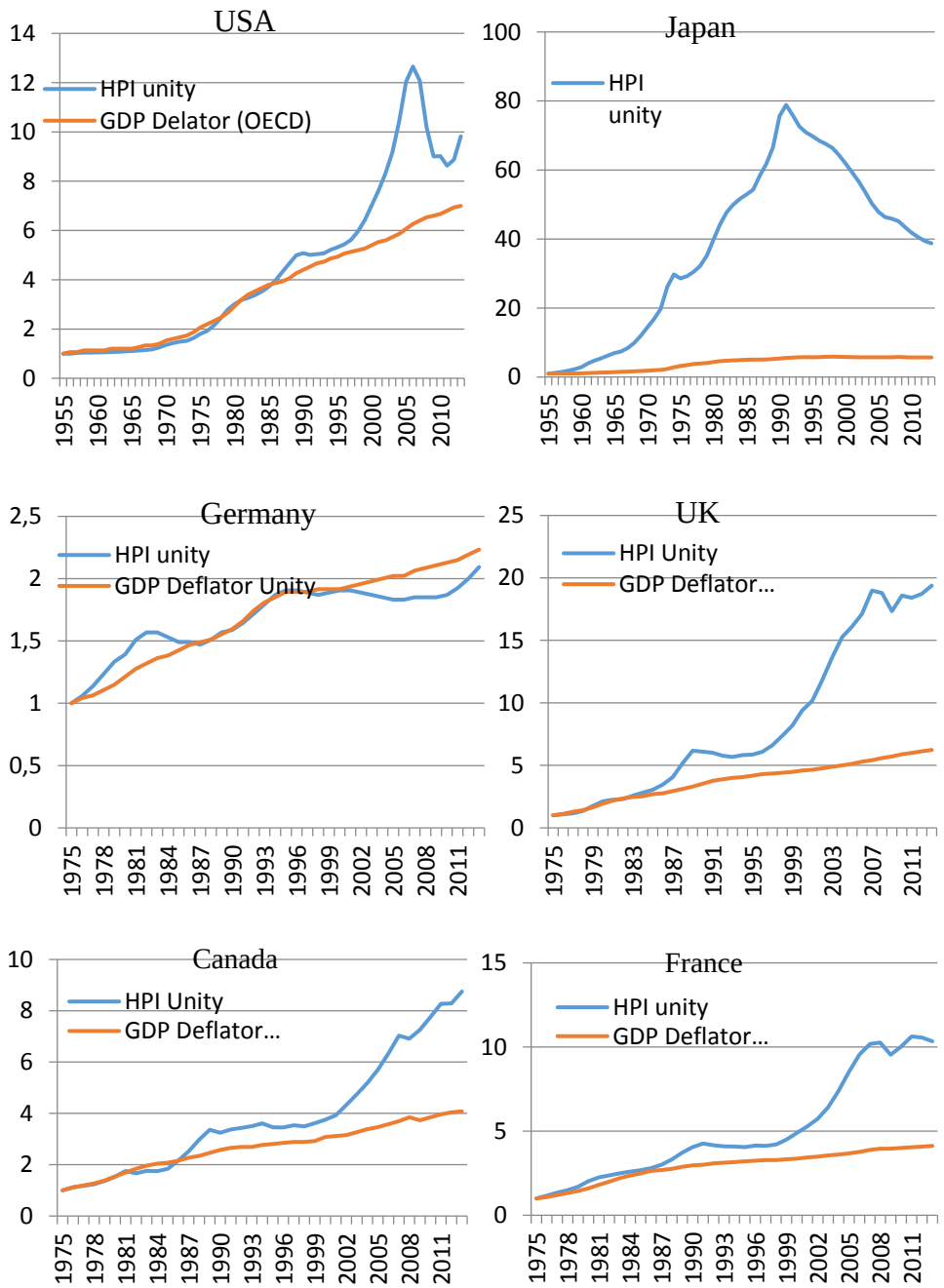


Figure 4.10: Secular development of house prices compared to general price development, last 4 decades[52]

[52] Data for the USA: HPI: Shiller, R. (2015). US Home Prices 1890-Present, Deflator: OECD (2015). OECD Main Economic Indicators (MEI). Data for Japan: HPI: Fed St. Louis (2015c). Residential Property Prices for the Japan, CPI: OECD (2015). OECD Main Economic Indicators (MEI). Data for Germany: HPI: Fed Dallas (2015). International House Price Database, GDP Deflator: OECD (2015). OECD Main Economic Indicators (MEI). Data for the UK: HPI: Fed St. Louis (2015b). Residential

The secular rise in relative prices became even more dramatic since the middle of the 1980s and a number of asset bubbles and financial crises were connected to house price volatility. A secular rise in housing and real-estate prices may be one of the major driving forces for inequality in the highest percentiles of the income and wealth distribution.

Is this secular rise of urban land prices an economic problem or does it just reflect relative scarcity and hence is an efficient consequence of market conditions? It could be both, first it is an efficient market result under given conditions. Therefore, with respect to efficiency this market outcome has to be considered efficient. However, according to the two welfare theorems there is an infinite number of efficient outcomes, and there is an infinite number of distribution supported by an efficient market system. Therefore a society can evaluate the resulting distribution and may decide about the question if a currently efficient outcome is a socially optimal outcome or if more inclusiveness is a better outcome. In this case societies have to decide if there are policies that may lead to another efficient outcome with a higher degree of inclusiveness and may be aware of these mechanisms once urban development policies are considered.

5 Effects of technological change and international technology transfer – the perspective of developing economies

After having discussed the effects of technological change and technology transfer for developed countries we now look at developing economies. First, we consider patterns of income distribution in developing economies and ask what the effect of technological change is on the distribution of income? And can we observe inclusiveness for major groups? Second, we consider explanations for non-inclusiveness of the generation and distribution of rents during the process of technological change, technological transfer and development.

5.1 Is the growth process inclusive in developing economies?

The effects of a transfer of technologies and technological change in developing economies can be discussed focusing on two aspects namely (i) the heterogeneity of observable trajectories over the huge range of stages of development real world economies are in and (ii) the transfer of technological change, which is essential for the development of a modern industrial and export sector.

Property Prices for the United Kingdom, GDP Deflator: OECD (2015). OECD Main Economic Indicators (MEI). Data for Canada: HPI: Fed St. Louis (2015a). Residential Property Prices for Canada, GDP Deflator: OECD (2015). OECD Main Economic Indicators (MEI). Data for France: HPI: Fed Dallas (2015). International House Price Database, GDP Deflator: OECD (2015). OECD Main Economic Indicators (MEI).

5.1.1 The heterogeneity of technological transfers and income inequality

With respect to developing economies there exists neither a homogeneous pattern of transfer of technological innovations nor are the effects of technological change identical in particular with respect to the issue of inclusiveness. Therefore, as a first step, we have a look at this heterogeneity with respect to indicators describing the income distribution.

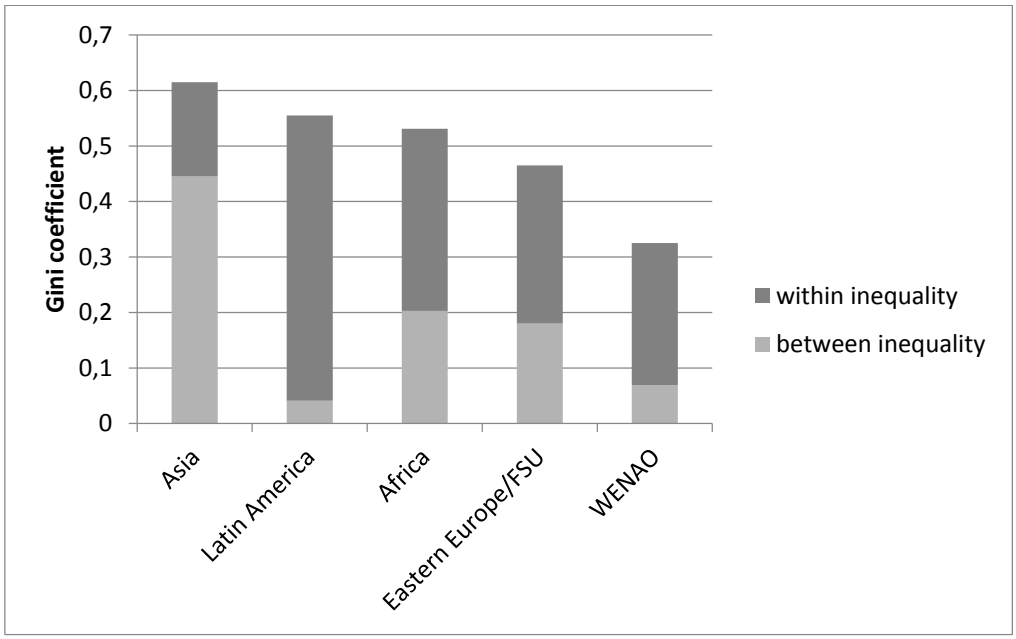


Figure 5.1: Inequality by global regions, within-country Gini and between-country Gini[53]

Figure 5.1 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, say for example. the African countries. The "within component" takes into account inequality within a country no matter of the inequality between countries of this group. In figure 5.1 we see that these two dimensions of inequality are very different globally. While Latin America is characterized by countries showing a relatively 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 high 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. Highest inequality is observable for the two middle income groups. When evaluating changes in inequality across

[53] Based on Milanovic and Yitzhaki (2002). Gini coefficients for (mostly) net disposable incomes in 1993 PPP $.

time, all, except the low income economies show an increasing trend. Further, high income economies have the strongest rise.

Comparing regions, as in figure 5.2, inequality has changed during the 1990s and 2000s in most countries considered. The groups, however, did not move into the same direction. While Latin American and African states reduced their Gini, Asia and Pacific and ECIS show a rise. There was not much change in Arab States.

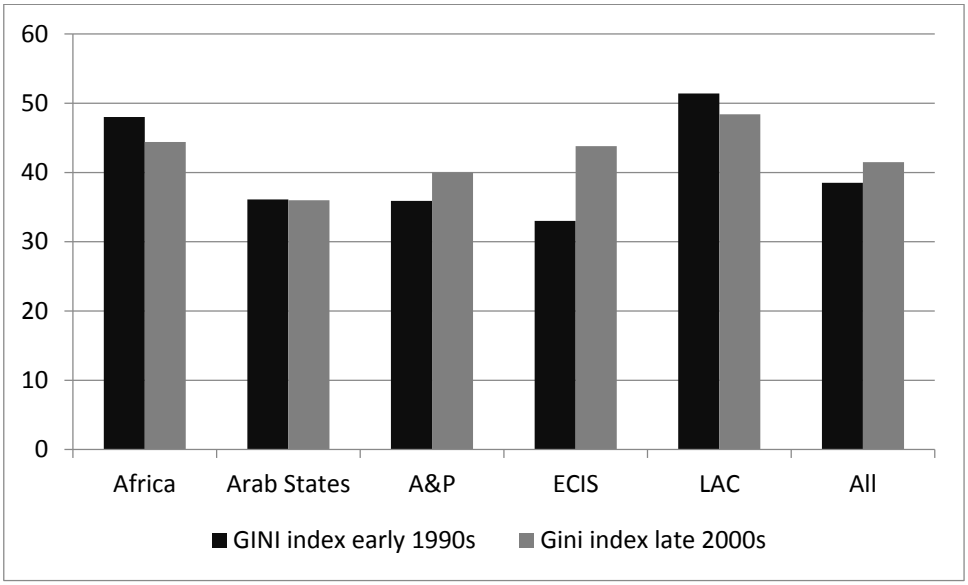


Figure 5.2: Development of the Gini coefficient for different regions (early 1990s and late 2000s)[54]

Therefore, unlike advanced economies, we find that heterogeneity is too broad for the large number of developing economies to describe the conditions as holding more or less in common for this country group. 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 or combinations thereof are characterizing some other countries. However, there is no country which is fully described by this narrative. It is a benchmark trajectory to discuss the process.

5.1.2 Growth of industry sector and towards a modern economy and society

Transfer of technologies and linking to international value networks as discussed in section 3.3 is a major driver of developing the modern sector in developing economies (Gereffi et al., 2001; Gereffi and Memedovic, 2003; Makki and Somwaru, 2004). Furthermore, the manufacturing sector is an important driver of productivity in developing countries. Figure 5.3 correlates

[54] Based on the United Nations Development Programm report Humanity Divided (2013). Gini refers to household income inequality as measured by the population weighted average level of the Gini index. ECIS = Europe and the Commonwealth of Independent States; A&P = Asia and the Pacific; LAC = Latin America and the Caribbean.

modern sector growth with overall growth. Since the 1950 it has grown more rapid than the primary sector (Szirmai, 2012). Adapting local technology to a global value chain allows a modern sector to participate in technological change and be a catalyst for development.

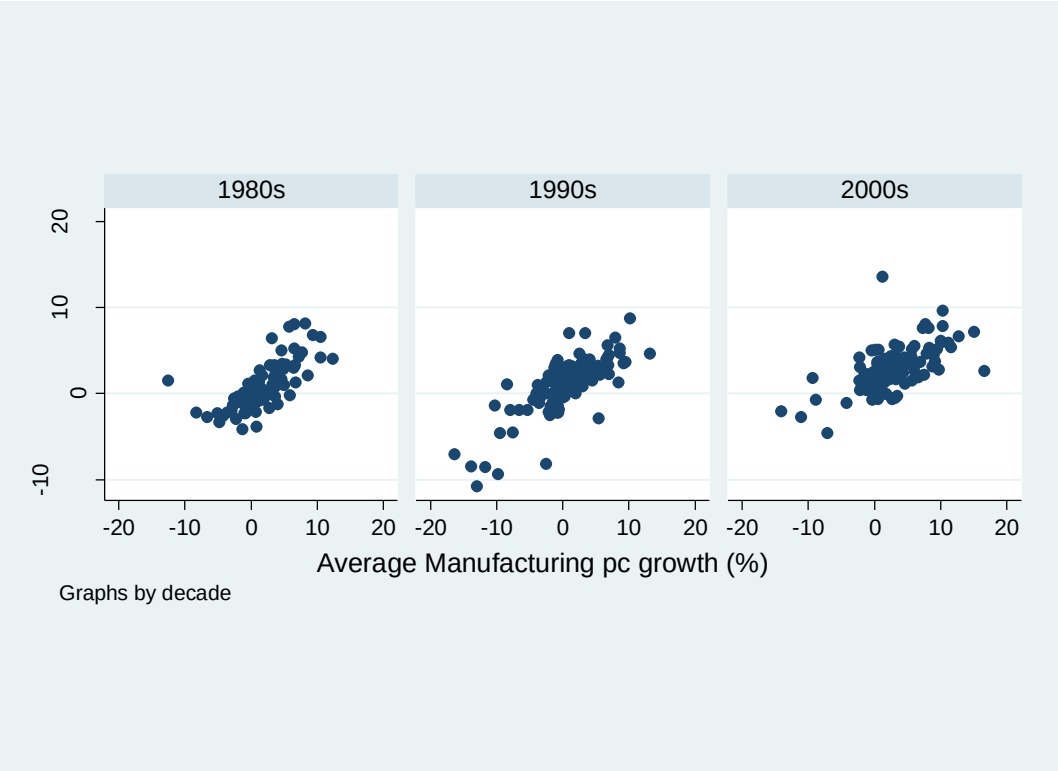


Figure 5.3: Correlation of modern sector growth and average growth in developing economies[55]

A number of positive processes are associated with manufacturing no matter if they are entities owned by foreign firms or if they are independent local firms:

(i) If such entities are active in a country, backward and forward linkages help to spread technologies into the local economy (Javorcik, 2004; Liu, 2008). The local economy can link to such international nodes and local firm themselves take over tasks or the production of further intermediate goods.

(ii) This interaction and the linkage into the local economy will cause additional learning by production advantages. There are learning and productivity gains through exporting. Especially important is that 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 Biesebroek, 2005). Local human capital will improve and additional productivity gains are the result.

(iii) Positive effects may not only effect local firms but also institutions (Robertson and Watson, 2004). The interaction of local institutions with the international value network may give incentives for an improved functioning of economic and administrative institutions and less corruption. However, the intensity of these spill-over processes and the extent of promoting growth depends on the kind and

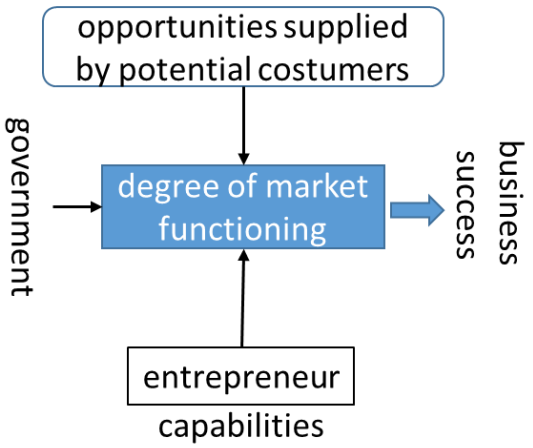
[55] Based on data from World Bank (2012) and Heston et al. (2012).

sophistication of the international value network and complexity of the production process.

In producer-driven networks the tasks 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 some kind of access to more advanced technologies. Due to skill requirements 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 the chance for a technology transfer of even more complex technologies.

In buyer-driven networks processes are less specialized. Often the process is also less sophisticated. With a lower complexity of the technology fewer and rather simple technologies are transferred. However, as the technology is mastered by the local firm it is less dependent. The local firm becomes able to the switch to other firms and substitutes connectivity to an existing value network with another. As a result we can expect positive firm or sector trajectories in these economies. Hence, let us draw a scenario which describes the more optimistic trajectory before we turn to shortcomings which are related to the issue of inclusiveness.

The optimistic path is related to strong linkage in the domestic economy. The technology transfer does not only affect 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 transform these opportunities in start-ups or firm growth of existing firms. Entrepreneurs define the link into the local economy and are the key driver of the development of a formal modern sector. This growing formal industry sector and industry related sector absorbs labor supplied by the Lewis labor pool. That is, labor abundance and comparative advantages in labor intensive tasks and the local developing firms generate jobs and by this reduces the most serious problem of unemployment. Generating more employment is not the only important effect caused by such modern sector development. Also the switch from an occupation with very low productivity to relatively high productive jobs is crucial (McMillan et al., 2014). Thus, structural change implies a "bonus" on aggregate productivity (Temple and Wößmann, 2006). By generating these industry and industry related jobs not only a large number of people are included in the growth process, also through the creation of jobs, average productivity grows and higher wages will also enable the employed labor to increase family income. Thus created income spreads further than only towards the directly employed. Furthermore, with higher productivity poverty is also positively affected. Even more important than the direct effects might be also the indirect effects: learning effects are of high importance. The transformation of the economic structure is crucial for a sustainable development and a catching-up trajectory towards the advanced economies.

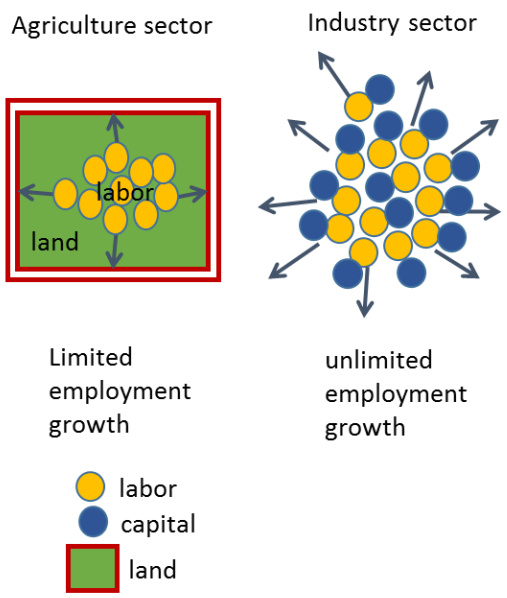


Box: Entrepreneurs, opportunities and market match

A successful market economy needs to have functioning markets.
In non-perfect real world markets functioning is better, the lower information and transaction costs including institutional costs.
New firms come into business if entrepreneurs have a business idea and this business idea matches preferences of costumers. These preferences define the opportunity of realizing the business idea. The chance to match business ideas and opportunities is increased with the degree of well- functioning of the market.
Thus, we see that markets can only work and promote growth and development, if (i) there exists capable entrepreneurship, (ii) there exists a potential demand providing opportunities for business, and (iii) a government that provides the institutional frame to let markets sufficiently function.

Why is the development of the modern sector superior to the development of the traditional agricultural or primary sector? Because there are three unlimited growth potentials. (i) The number of firms grow, (ii) the value of firm growth and (iii) the labor growth related to both of these growth potentials do not face any natural limitation.

Box: Growth and employment potentials: The modern sector versus the agricultural sector



The modern manufacturing sector and the agricultural sector show different potentials for employment growth.

In the agriculture sector fixed land is a fundamental restriction. The fixed supply of land does not necessarily limit income growth and productivity of this sector, but it limits employment growth. Income can grow via fertilizers or capital intensity. However, both increase productivity per unit of land and simultaneously per labor. Thus, employment expansion is restricted by total land available.

This is different in the modern industry sector. Industrial production has no naturally fixed factor that would limit growth. Labor can be combined with capital and production as well as employment can potential expand without limit as long as there are no limitations of demand.

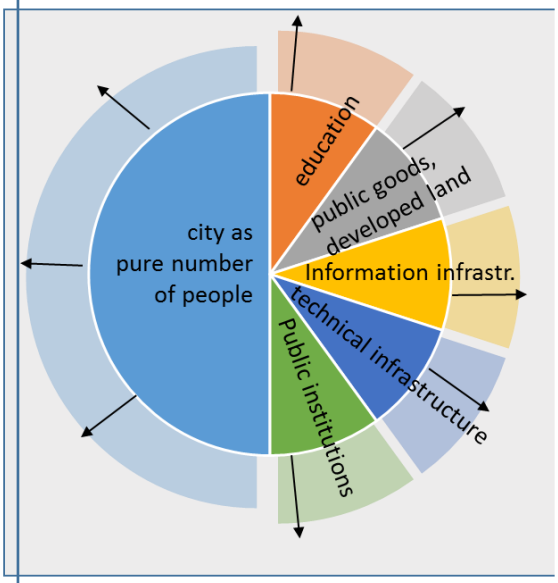
The growth of the number of firms addresses the fact that it is sufficient for a firm to exist that an entrepreneur discovers an opportunity that serves for any needs costumers have a willingness to pay for. As long as demand is unlimited capital and labor can be combined to satisfy the demand. At least in the ideal case talented entrepreneurs can discover an opportunity, acquire the resource and labor and get a financial footing to realize the business idea which eventually turns into a successful formal firm. This gives chances to an unlimited number of entrepreneurs to transform a vision into an economic process which can be fed by capital accumulation and innovation without physical limits. A modern sector implies loads of opportunities for talents. Talents spot opportunities as entrepreneurs or a productive positions in the producing economy. Without such opportunities in a growing and successful modern sector talents may select to become rent seekers instead of producers (Murphy et al., 1990).

Similar for firm growth, if a start-up is successful there is no limit for firm growth in principal. A successful business idea has led to a firm and can expand unless market limits are reached. 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. This later fact is particular important for developing countries. The most important problem in developing countries is the pool of unemployed labor which seeks for a sufficiently productive occupation. Which kind of production process can sustainably absorb this kind of excessive supply of labor? Only the modern sector has this potential capacity. For the agricultural sector land is the crucial factor. The agriculture sector can use only a limited amount of land. Even if the value of this limited space could continuously grow as a stock of capital the ability to absorb labor is limited. That is, farm land on the one hand shows characteristics comparable with other forms of capital like a potentially unlimited growth in value, on the other hand with respect to the creation of employment there are clear limitations. Therefore, an agricultural dominated economy can potentially grow in value driven by land productivity and the value of land. However, this growth includes only the limited number of people connected to farming. Even more, if there is a Lewis labor pool gains from productivity growth are allocated basically to an even fewer number of land owners. Hence, in an agriculturally dominated economy a large share of the labor force cannot broadly participate in benefits from technological change. Inclusiveness in benefits of technological change cannot be expected.

Turning back to the positive elements for development. The transformation of the economic structure leads also to a social transformation. In social terms we see a transformation from a traditional society to a new social system and community. This transformation affects various dimensions. Urbanization and the fast growth of urban agglomerations is an apparent and visible observation in this respect.[56] Urbanization and agglomeration is 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, lower transaction and information costs allow an easy diffusion of ideas and knowledge (Puga, 2010;

[56] As we are describing the positive trajectory urban society means a center as described in regional economics as 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, center of higher and highest education.

Gries and Naudé, 2008). These are attributes related to a well-organized urban development. Here, with 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 be aware of very different qualities of urbanization once we further develop and discuss this transformation process.[57] However, in urban cities we observe a transformation of a society dominated by rural and traditional rules to an urban society. This transformation is a cultural revolution, painful for existing societies. This transformation comprises large potentials for conflict as traditional beliefs, rules and rulers are losing power in favor of a new (and secular) system of rules. Most prominent is the change in influence of religion and the role of women in public and private life.



Modern sector development is closely linked to urbanization and agglomerating centers. Positive and growth promoting elements can only be preserved during long periods of expansion if balanced growth of all functions of an agglomeration is organized.

Quality of urban growth depends on the simultaneous extension of functions that define an urban center. These elements are the supply of education, public goods and developed land, physical and technical infrastructure, information infrastructure, and public institutions. These elements must grow in balance with the urban population to avoid congestion costs and diseconomies of scale.
Thus an efficient modern sector development requires a continuous supply of such additional elements.

Further, the evolvement of a modern formal sector gives the government a tax base and allows for a sufficiently paid for public sector. This public sector may become less dependent on bribes. A sufficient tax base also enables the government to improve institutions, economic, administrative as well as political institutions. With participation of 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 also in the political process. Paying taxes gives these economically successful groups the self-confidence to also take over responsibility in political decision making. Political inclusiveness may follow the economic inclusiveness, if wanted by the culture of such a successful ideal economic development trajectory.

Further, with social transformation demographic transition may also take its course. A growing modern sector induces a higher labor market participation of women and affects the decision

[57] For an account of different qualities in urbanization see e.g. Gollin et al. (2013).

between the pure number of children a woman wants 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, the increasing modern sector may induce fertility decline. Dropping fertility rates further allow a shift of resources towards a better education of children and thus enhance human capital formation and labor productivity. Thus, a growing modern (export) sector is also a likely major determinant of fertility and demographic transition (Galor, 2012; Gries and Grundmann, 2014). With the demand for secondary education in the modern sector and with an urban life, a family needs more qualified children with higher productivity and high earnings than low earnings for physical labor supply. Being situated in an urban modern sector, for substantial support, of both, direct family income as well as family risk insurance, qualified human capital is more important than the pure number of children. Thus, this decision reduces fertility and increases human capital investment simultaneously and implies a lower population growth with a higher quality of education. Demographic transition follows a similar pattern as known from the advanced economies.

5.2 What causes non-inclusiveness in developing economies?

The above section is a description of a 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 in reality followed this particular narrative. The reason why we draw this picture is 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 for inclusiveness. So what can be reasons why the process of technology transfer and structural change may be non-inclusive for a major part of the population in developing economies?

Technology transfer is described via linking up with a global value network. Two major mechanisms were suggested for this link. FDI and trade, and independent trading firms. Both of these links that can promote technology transfer may have shortcomings with respect to inclusiveness. The described value networks are not acting in an ideal competitive market environment. Hence, there are not only efficiency gains, there are in addition pure rents detectable in all kind of arrangements within the organization of the network. The exploration of these rents is an important element of the business model of such global value networks. After exploring these rents the distribution of them is the second important element. Asymmetric information, hidden action and a principal agent problem illustrates these problems (as describe in section 3.2). However, here we would like to check for local labor in developing economies and their chance to participate. As in the discussion above technology transfer is generally positive as it allows to absorb labor from the Lewis labor pool and to bring formal jobs in a growing modern sector. However, even if this can be regarded as a contribution to inclusive growth as described above, there are also shortcomings from the perspective of local labor. What are the specific conditions and characteristics of this technology transfer that allows for rents? Which conditions could imply more inclusiveness for a larger share of local people in particular labor when technology is transferred?

5.2.1 Rents, FDI and firm internal trade

We start with the FDI and trade link: These networks, no matter if they are producer-driven or buyer-driven networks 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 connectivity to the network and the transfer of technology. As the 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 can only take the option of accepting whatever 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 wage paid in the market and the wage 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 originally was 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 had a value of 10 units of currency and employed 10 unit of lower skilled labor when it is installed. Skill-biased technological change leads to a depreciation of the installed capital vintage in the advanced economy, let us assume at a rate of 10 percent a year. Hence after some years this capital vintage is worth only half of the original value. Hence capital intensity has decreased through machine depreciation. An originally capital intensive process has turned into a labor-intensive process as the same 10 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 fully economically depreciated under the wage-interest rate relation in the advanced economy. A new capital vintage becomes more profitable and replaces the old vintage.

However, having fully depreciated the machine in the advanced economy at relatively high wages the technology now has tuned into a labor-intensive process. From the viewpoint of the owner in the advanced economy this machine and the embodied 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 was fully depreciated at a wage rate of 10 units of international currency in the advanced economy. Than the firm knows that the same machine would still make profits if the firm could find a location where the local wage rate is at most 9 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 9 units or less. 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 9 to 1 - and the transfer of the technology leads to rents generated by this wage gap. The segmentation of global labor markets allows for the emergence of such rents.

Are these rents a temporary phenomenon? No, these rents 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 has not been reached. Even if an economy comes close to the Lewis turning point, the production process may be shifted to another country in which 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 the global scale there is no turning point in the foreseeable future.

(ii) To absorb labor by offering jobs in a modern sector capital needs to be accumulated and machines need to be physically existing and 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, the machines. The installable machine is available as the result of a technological depreciation process. Existing machines have no or very low values as they are 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 a limited machine capital. In addition there is also a lack of low price machine capital 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. Even more, the technology is not adjusted to the skill and labor conditions in the developing countries.[58] Only recently emerging countries like China or India are on the way to develop a significant own investment good sector which may be able to develop own technologies better adjusted to conditions in these countries. 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 are disappearing during a foreseeable time.

As the global value network is controlled by the headquarters in advanced economies these rents can be completely distributed within the transnational firm. In the scenario of the classic capitalist firm shareholders benefit by far most from these rents. 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. In contrast, in a stakeholder firm all kind of groups may benefit including the local producing task. Local resources could be paid above local wage, they could enjoy a higher degree of occupational safety or be included in social security or health care programs.

5.2.2 Rents in independent trade processes

Independent trading firms: The second link for a technology transfer from the advanced countries to backward economies is through pure trade. In this case a local firm in a developing country can link up to a global value network by supplying a task or intermediate good for the international value chain. Three preconditions are crucial for this to happen, first the local firm

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

has comparative advantages in the respective task or intermediate good; second, the firm has the technological capability to produce a high quality products which can be an element of such a global value chain; and third, local entrepreneurs or managers are able to acquire respective orders, and hence have the necessary technological and engineering skills, and managerial and communication capability for doing so (Ernst and Kim, 2002; Gereffi et al., 2005). In this scenario the entrepreneur is the most important link in the chain that connects the local backward country or region with the advanced world. The entrepreneur is the key element from the perspective of the backward country, the entrepreneur is the only one that can substitute for the function of the foreign firm. His ability to imitate and transfer the imitated technologies to the local conditions and simultaneously keep connectivity to the international network determines the success of an independently acting local firm. While in a first phase this imitation is likely to be related with 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 means 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 is related to emerging market economies. They are not just emerging as markets with an increasing purchasing power, these economies are also characterized by the ability of an increasing number of firms to become globally active and imitate mature global firms so far most often located in advanced economies.

With successful local entrepreneurs as elements in international value network it becomes likely that developing countries are 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 FDIs. In this scenario, instead of transnational firms entrepreneurs and higher educated labor as manager or engineer arrange 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 be taken also by local entrepreneurs. We now observe that local entrepreneurs and high educated labor is potentially able to participate in the rent distribution of international value networks. Hence at least a group in a developing country namely, local entrepreneurs, could be included in the 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 to establish a middle class. However, this depends on market conditions and the degree of competition for these goods from such developing economies firms. Low profit margins in developing economies are due to high competition in buyer-driven value chains could again redistribute rents to value networks controlled by firms of advanced economies. Competition is carried out by squeezing wages instead of increasing productivity (Giuliani et al., 2005). Further, an increasing wage gap is not only a phenomenon in advanced economies but also widely observed 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. 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, now transferred to developing economies (Verhoogen, 2007). The argument suggests that an increase in foreign direct investment (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 technological transfer 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 corresponding to 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 higher skilled 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; they also identify other factors like an alleged 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 is only partially or not included due the same arguments as we discussed before 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 transitorily available but a solid base for further development. Hence some of the rents can be regarded as rewards for this important step. An active local entrepreneur is the most limiting factor that is needed to develop a self-sustaining formal market economy. Such entrepreneurs not just need to have the relevant skills, either technological engineering or managerial, they must also find sufficient infrastructure and institutional conditions.

5.2.3 The role of the local government in developing economies

For developing a market economy inclusive growth requires the development of entrepreneurship. In addition to large firms, small and medium size firms are important. Such decentralized firms can be a driving element of capital and wealth accumulation and lead to high employment. In order to let entrepreneurs search for opportunities, realize new business ideas and newly found firms, or in order to expand existing firms, institutions for a well working market system need to be created. Some of them have already been mentioned (see section 3.3).

First, as it is likely that a local firm connected to an international value network can gain rents, firms in the formal sector can be regarded as an income source for the government and public administrative body. If the administrative sector is low paid and culture does not proscribe

bribery, bureaucracy may try to channel some rents in its own favor. (Robertson and Watson, 2004). Even if corruption is perceived correctly, firms believe in its arbitrary nature. That is, corruption hits all, even though not all firms are currently involved (Doh et al., 2003). If the corruption level becomes too high and reduces activities of firms (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 less opportunity. However, from the discussion it becomes quite clear that bureaucracy can absorb such large share of the rent that the incentives for entrepreneurs disappear. As a result a corrupt bureaucracy may become a serious cause for low growth of markets and a serious obstacle for technology transfer to such countries.

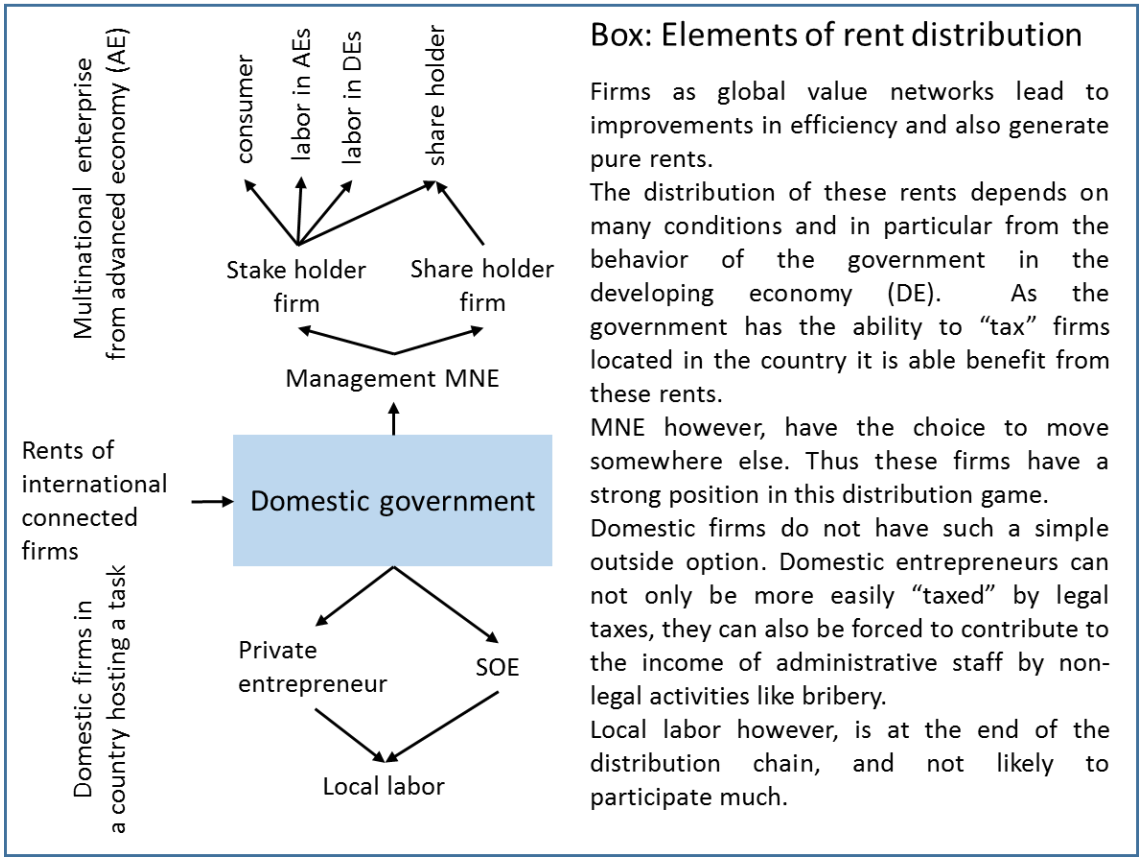


Figure 5.4 relates economic success measured by GDP per capita to the degree of corruption in a country measured by the corruption perception index (CPI). As a higher CPI indicates less corruption it becomes apparent that high income economies perform better and have a lower level of corruption.

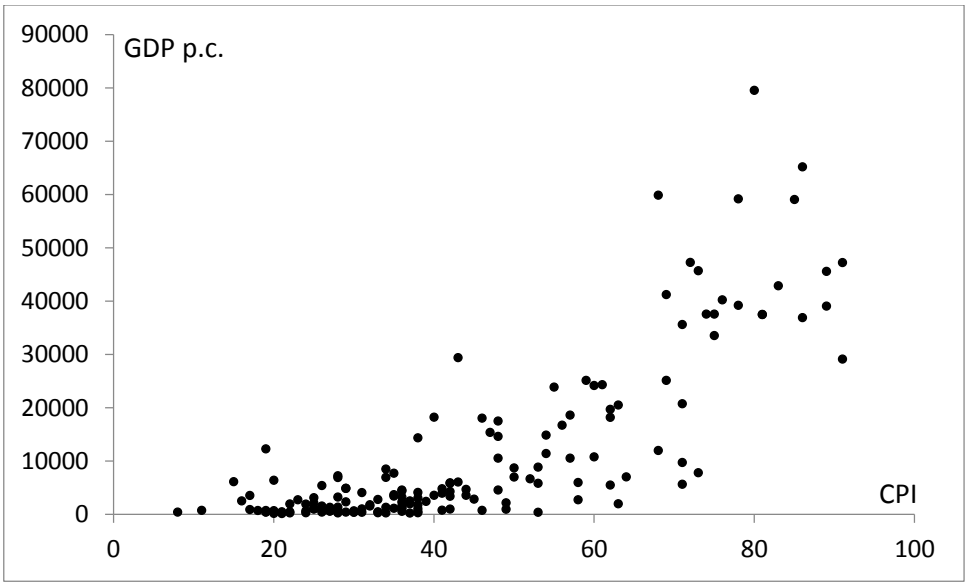


Figure 5.4 Corruption Perception Index and GDP per capita (constant 2005 US$) for 160 countries in 2013[59]

The second element directly related to government activities is the design of trade and internationalization policy. When designing trade policy governments have to balance two objectives. Conditions in the country must be attractive for foreign firms to invest, and the foreign firm should be encouraged by incentives or forced that technology is in fact transferred 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 of the social costs.[60] E.g. the Chinese government carefully designed policies that lead to joint ventures or firm cooperation that fostered technology transfer to Chinese resources. In the first phase of Chinese open up policy the spill-over effects were much less and the local economy could not grow as fast as in the second phase since the 90s when the Chinese took more care of such transfer processes. The Chinese case also shows that not a pure liberal trade policy is most successful, but one which is directed towards the countries own interest in particular with respect to the transfer of know-how.

The third element that could be of high relevance are active international rules or institutions. International organizations can promote rules which can lead to more inclusiveness. An example is the enforcement of work 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 work protection conditions and health conditions can be generally acceptable objectives. Furthermore, housing, fresh water or sanitary facilities or even hospitals for migrant or regular workers and their families could be in the focus of such rules that might be established. Seals of approval could assure this quality management and serve as a means of communication towards both, the public and the consumer. This kind of communication and disclosure of good or bad conditions is a step towards higher market efficiency. For many consumers the “fairness” and “non-exploitation” during the production process can be an

[59] World Bank (2014); Transparency International (2014).
[60] Krautheim and Schmidt-Eisenlohr (2011) discuss this problem with respect to tax competition.

important element that characterizes a product. Therefore, if these informations are not available consumers cannot differentiate and asymmetric information leads to market inefficiency.

However, even if public institution are not able or willing to establish such information and control networks private organizations could easily substitute for missing governmental institutions and rules. NGOs can establish private rules and certify those producers who follow. If these NGOs are able to establish a network that is transparent and easy to understand they may become able to establish a reliable instrument that helps the consumer to obtain more relevant information for better decisions.

6. Effects of technological change and international technology transfer – a global perspective

While the issue of inclusiveness so far was discussed within the technology driven growth process of countries and country groups it is also worth to look at a comparable global picture. So far most discussion focused on income and productivity differentials either between countries or within countries. Differentials between countries compare averages of per capita income for each country. And studies focusing on within country differentials try to explain income differentials within an economy. Considering the world income distribution and the question which groups could benefit from the global development is a new perspective. Hence recent contributions tried to focus on such an integrated view (Milanovic, 2011; 2013; Bourguignon and Morrisson, 2002). By taking this perspective we can ask two questions: How did the recent process of world development, characterized by skill biased technological progress in the advanced economies and developing economies and a dynamic world market integration of large shares of the world population with lower income, affect the world's income distribution? Who gained in particular from this process and who could not gain significantly or even had to experience losses?

So far, in sections 4 we looked at the advanced economies and inclusiveness within advanced economies, or in section 5 we examined inequality within developing economies and also between developing economies. Milanovic (2013, figure 3) gives another example for comparing inequality within countries by choosing representative countries (US, Brazil, and Sweden) for certain groups. Here, the US stand for Anglo-American model of market economy, Sweden for a more European model and Brazil for conditions in emerging markets.

However, in contrast to these country comparisons of inequality we now try to obtain a more integrated global view. In such an integrated global view individuals are taken as global citizens.[61] Hence a global income distribution for all citizens no matter of the country of origin can be described. Milanovic (2013, figure 3) presents a "World" Gini coefficient derived from such an integrated concept for the world income distribution and shows how much the global

[61] Milanovic combines individual or household surveys from across countries and seeks to make the data comparable. However, as surveys' methodologies and procedures vary, there may remain limitations.

income distribution is more unequal than the one of any representative country.[62] However, more interesting than the pure level of the Gini, in particular with respect to the question of inclusiveness, is the development over time. The results indicate that there is barely any change in world inequality during the last two decades, measured by the global Gini coefficient.

However, this is the most aggregate and broadest of all views. Having in mind the more detailed discussion of the above sections and asking the question of inclusiveness we must find corresponding effects in this integrated view of the global income distribution.

Hence we take a closer look into this joint and integrated distribution. First, we would like to get some idea about the ranges of overlapping income levels. If two countries have different overall income levels then it can still be that the upper income groups in the poorer country have a similar income as the lower income groups in the richer country. Milanovic (2013, figure 7) illustrates this overlap by presenting the country income for USA, Russia, Brazil, China and India compared to the percentile of world income distribution. He shows that e.g. the median income in Brazil has an income position located at around the 60th percentile of the world income distribution. This 60th percentile is also the income level that accrues to the lowest five percent in the US. In turn this means that the lowest US incomes are comparable to the median Brazilian income. Taking the lowest five percent US income for comparison, in China only the top 15 percent reach this level and in India only the highest five percent have a comparable income level. However, given the large populations of both, this still represents some 200 and 60 million people, respectively and already indicates how economic changes in these countries affect the world income distribution. In order to discuss these dynamics of world income distribution and the question of inclusiveness Milanovic (2013, figure 5) focuses on the concept of the Lorenz curve.

Comparing the Lorenz curves for 1988 and 2008 he shows that the two curves are very similar. Thus, the world income distribution described by this measure does not seem to have changed too much from an overall perspective. However, the two curves intersect somewhere 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. We may derive that these income groups had been at least weekly included in the positive income effects of technological change. However, with the Lorenz curve we cannot see the redistribution within the lower 80 percent. Turning to the "rich" end of the income distribution another pattern appears. In 2008 the upper one, five and ten percentiles earn a larger share than in 1988. This is 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 two relatively winning groups leading to a change in the structure of the world income distribution.

We further explore this pattern using the relationship between the each percentile of the world income distribution and the percentage income change between 1988 and 2008 presented in Milanovic (2013, figure 5)

He shows that taking a median gain of around 40 percent, starting with the 20th percentile middle income groups up to the 70th percentile were increasingly gaining, with the strongest

[62] That the global is larger than the one of any country should be almost by definition true.

gains between the 40th and 70th percentiles. Diffusion of technology towards countries which before were not able to use modern technology is most likely a major reason for this decrease in inequality (Firebaugh and Goesling, 2004). In particular large emerging market economies and most particular China contributed to the gains of this income group and therefore a higher equality of world income distribution (Milanovic, 2013; Bourguignon and Morrisson, 2002; Davies et al., 2007; Ferreira and Ravallion, 2008). In China both, poverty reduced due to reforms in the agriculture sector and large growth rates in the industry sector enabled a significant share of the labor force to get 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, is contrasted by difficulties of large groups of households in advanced economies, Latin American or former Communist economies (Milanovic, 2013) and the fact that the very rich gained extraordinary, 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 also represents to a large extend households in advanced economies. Except for the very rich most of these groups are far below the median real income gain. 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 responsible for the difficulties of these income groups. The falling behind of large groups in these countries sheds an interesting light on the current functioning of especially the advanced economies. While we do not observe that advanced economies are on average in a difficult situation, there are stark differences within. The highest income groups are still gaining massively relatively to other groups in the country and worldwide. Middle and low income groups fell relatively behind, possibly due to the lack of participation 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 poverty reduction made progress during the last decades, the lowest five percentiles could still not equally participate in the global income gains.

We can now turn back to the overall question of this contribution and try to give an answer from a global perspective. Is technological change socially inclusive?

For the global perspective the income-income change perspective presented by Milanovic (2013, figure 5) can help to give a differentiated answer. We use the term that a process of technological change and growth was “inclusive” for a group by relating the respective effects to the median effect. A process is regarded as “strongly inclusive” if it could gain more than the median. A process is “weakly inclusive” if it could not reach the level of the median, and a process is “non-inclusive” if absolute income remain broadly unchanged.

With this definition we can give concluding answers. Technological change and the global diffusion of technological change via technology transfer was strongly inclusive for a large range of middle income groups of the global income distribution. These middle income groups are located in emerging markets and middle income countries (Farrell et al., 2006; Kharas, 2010). In particular Chinese higher and upper middle income groups were included in the positive effects of this process through rather high income growth. Middle and lower income

groups in the advanced economies however were only very weakly included in the benefits of technological change during the last two decades, even if technological change has its origin in these countries.

The richest global income groups gained significantly and contributed to higher income inequality in particular in advanced economies. Alarming however remains that the poorest five percentiles were almost excluded from the benefits that technological change had brought to global development.

7. Policy implications

The major channel of transfer of new technologies and innovations is through the connection of developing countries to the international value chain or network. This connectivity together with the appropriate local conditions combine to a technical, economic and business capacity that allows to form a modern manufacturing sector. Firms in this modern manufacturing sector should follow a dual strategy. First, they should continuously be able to match requirements of international competiveness and remain a receiving element of innovations originally introduced elsewhere. Keeping connected enables the transfer and imitation of technological change generated by other firms in other economies. Second, firms in the domestic manufacturing sector should use their technological, economic and business capabilities to root themselves as much as possible in the domestic economy by building backward and forward linkages, which can generate spill-overs and promote the development of a domestic market.

Linkages and spill overs will allow other firms to develop and enhance the domestic industry sector. Moreover, technological capability can also be extended to other fields which could match opportunities provided by a high potential demand of domestic costumers. If the domestic market can absorb a large amount of goods belonging to medium-low- or medium-high-tech products, like motorbikes, sewing machines, tools, furniture, clothing, manufactured consumption goods, or simple investment goods, internationally connected firms can use their international connectivity and abilities to develop the domestic markets for such goods. This is even more appropriate as these goods are often in accordance with the international comparative advantages. Enhancements towards domestic markets and expansion of product variation might serve not only domestic needs in terms of product characteristics and price. Such an extension of activities may also prepare for markets in other countries with comparable characteristics and opens up further opportunities for south-south trade. Firms following this path switch roles by moving from being a dependent task node in a complex value network to being an organizing node or headquarter in a less complex production chain. This is a new role that needs to be learned. However, it is an important step as it reduces the dependence on the current value network.

An active and comprehensive policy to promote the two strategy pillars of successfully operating modern sector firms should address at least three main fields of policy action: capacity building, promotion of international market connectivity and promotion of well-functioning domestic markets. These require the provision of appropriate infrastructural conditions. Furthermore, the traceability of production and environmental conditions is an important aspect

with regard to consumer choices in favor of improved working conditions and sustainable development.

Capacity building

A market driven development of modern manufacturing industries requires entrepreneurs. Entrepreneurs are the key actors who can discover opportunities and match them with business activities. Successful entrepreneurship in the industry sector requires, apart from personal characteristics, technical, economic, business, and communication skills. In developing countries we clearly see a lack of such capacities. Differentiated schooling systems that can provide the necessary capacities are needed.

(i) Education in engineering, communication and business skills at university level will help to bring about entrepreneurs, managers and engineers who are able to imitate technologies and business models and explore opportunities. Such education programs should be located in developing countries and supported by partnerships with advanced economies to adjust teaching, examples and experiences to domestic conditions, thus reducing incentives for high potential young people to flow off domestic societies by studying abroad. (ii) Vocational training and professional education below college level is another important aspect of capacity building. Many jobs in the industry sector require specific skills which need to be learned on top of general schooling. (iii) Internship programs for potential entrepreneurs in successful firms of the domestic economy or in international firms help to get experiences with firms in a real business environment. Such internships simultaneously build connectivity channels to global value networks. (iv) Advisory and consulting programs as known from venture capital and the SME sector in advanced economies, e.g. like the “business angels” etc., could transfer business experiences to less experienced emerging firms and entrepreneurs in developing countries.

Box: Entrepreneurial capability and international connectivity

The domestic firm must be able to offer a competitive product, and the domestic firm must be able to match producible product characteristics with costumer's whishes. That is, domestic entrepreneurs need to find information about potential customers to communicate with. At the same time international customers need to find potential suppliers and need to evaluate reliability, quality and credibility. Investments in such information are expensive on both sides and are a barrier to market entry. Thus, an institutionalized organization supplying such market information and evaluation may help to overcome the information asymmetry on both sides.

Promotion of international market connectivity

Connectivity to international value networks requires two conditions. The domestic firm must be able to offer a competitive product, and the domestic firm must be able to match producible product characteristics with costumers' wishes. That is, a domestic entrepreneur needs to find information about potential corporate customers to communicate with. At the same time international corporate customers need to find potential suppliers and assess their reliability, quality and credibility. Investments in such information are expensive on both sides and may serve as a barrier to market entry. Thus, an institutionalized organization providing such market information and evaluation may help to overcome this information asymmetry on both sides.

The classical chambers of industry and trade may cover this idea of an institutional function. They collect information, analyze the business environment and suggest how conditions may improve. They also know the firms they accompany and have information that the firms need. These platforms can be expanded to organize the international connectivity more systematically. Such a platform can be a forum for information exchange about product portfolios of domestic and international firms, project calls and project negotiations, intermediation of judicial conflicts between domestic and international firms, and even offer information and access to international financial markets.

With respect to the financing of domestic industrial projects such platforms may also play a role. While FDIs are projects which are fully financed by international firms, domestic firms often have to rely on domestic financial sources. This is difficult because the finance sector is often not well developed. Thus we suggest that foreign direct finance (FDF) may become an instrument that channels resources from advanced economies to modern sector investment

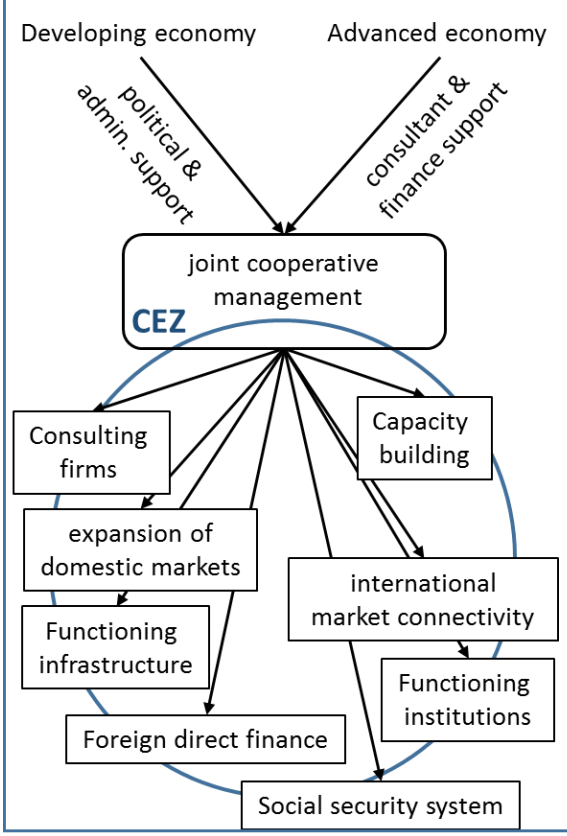
projects. This instrument may become a realistic channel of finance if information asymmetries can be reduced by such institutions and an efficient monitoring can be organized even if the financing institution is not a domestic bank. Then financing such projects can be regarded as a kind of venture capital from the perspective of the financial firm.

Promotion of functioning and expansion of domestic markets

For the functioning of the domestic market we generally see similar fields of discussion. Institutions must enable a match of opportunities offered by the market to entrepreneurs. If for a certain stage of development certain product groups are on potential demand in a country domestic firms should be enabled to become a major supplier of such products if it fits in the pattern of the countries comparative advantages. However, even if the domestic market is characterized by matching products with customer's needs and their resulting willingness to pay, high domestic transaction costs regarding information and administration as well as high uncertainties, both natural and government made, are often an obstacle for domestic firms to target the domestic market. And keeping them away from exploring related but new fields of business that varying from existing activities. Here again instruments similar as for connecting to the international market can help to connect to the domestic market and even further, actively develop the expansion of the domestic market. Markets which yet do not exist because of too high information, transaction and institutional costs should not be disregarded. Markets can be actively created by promoting entrepreneurial activities if a set of potential opportunities exist.

Cooperative economic zones

Cooperative economic zones (CEZ) are a combination of special economic zones and a specific kind of development and aid policy of advanced economies. They present an instrument to concentrate and implement the elements of capacity building, promotion of international market connectivity, and promotion of functioning and expansion of domestic markets in a geographically closely defined area. Thus, the institutions that are broadly described above are located in these zones, for which a functioning infrastructure for physical processes, information, knowledge and functioning institutions are the backbone. A CEZ is typically also defined by the following elements:



Box: Cooperative economic zone (CEZ)

A CEZ concentrates the elements of a functioning infrastructure for functioning markets (like in an advanced economy) in an area of a developing country.

A joint cooperative management of experts of both advanced and developing economies will provide all expertise and support necessary to make the zone economically functioning.

Fields of joint expertise and action are capacity building, promoting international market connectivity, promoting of functioning and expansion of domestic markets, consulting firms, intermediation for foreign direct finance and providing functioning physical, information, knowledge and institutional infrastructure, and a social security system.

Measures of the activities of the joint management are financed by advanced countries as a form of aid for developing socially inclusive market economy trade.

(i) A CEZ is managed cooperatively by the domestic administration of the LDC and a co-management coming from a supporting advanced economy taking over consulting responsibilities and sponsorship. The cooperative management is in charge for the functioning of all economically relevant institutions and is responsible to guide and assist foreign and domestic firms. Domestic firms are supported either to connect to international value chains, or to develop and expand domestic markets in existing or new fields. Domestic firms can also be escorted to foreign direct finance.

(ii) Foreign firms are advised when entering the domestic economy and will benefit from a functioning infrastructure, institutions and reliable information needed for an investment. A CEZ may also be included in cooperative trade policies. Such policies can give incentives for more economic, social and income inclusiveness. E.g. foreign directly investing firms may be rewarded if they cooperate with the local economy and link up sufficiently with local firms. Exporters may be rewarded if they enforce higher occupational health and safety regulations or pay higher than normal wages. International firms may be rewarded if they actively contribute to education and capacity building programs by offering internships or providing assistance for entrepreneurial or managerial education and other required skills. International importers may obtain better finance conditions if they cooperate with local firms.

(iii) Incentives and policy measures currently discussed for promoting more inclusiveness in the gains of technological change can also be transferred to other fields. The establishment of sustainable industrial development can be similarly addressed. Expertise of CEZ institutions can help to give advice on how to establish sustainable industrial processes and help firms to find funding or even give financial support. Furthermore, monitoring possibilities and

proximity of the respective processes can give high credibility to both, the effectiveness of the intended policies and financial sources.

(iv) Even experiences with an introduction of a social security system can be made. Most advanced economies have implemented a social security system. Hence, learning from the functioning and the problems of such system is important for a society in a developing country.

(v) Experiences from CEZ may be seized for the elaboration of a pro manufacturing development strategy and for an efficient support system that can help such development.

Global certification of production and environmental conditions

Most markets are markets for non-homogenous goods. Unlike homogenous goods, these products have multi-dimensional properties and characteristics which are all considered when purchasing decisions are made. The price is one of many relevant properties, but it is not the only one. If consumers have additional information about characteristics of goods they can decide themselves whether this information is relevant for their choice or not. Such product characteristics are pure properties like design, quality, technology, efficiency, or user-friendliness. These properties are either easily observable, or they may be revealed by the firms themselves. Firms can explain the advantages of the new technology embodied in the product, or the advantages can be revealed by experts testing the product and evaluating it or comparing its characteristics. Anyhow, often consumers need information which are hidden even if they are important for a decision, because they are elements of their preference order.

For many consumers one important characteristic of a product is the quality of the production process. The way how a good is produced is an element of consumer preferences. With respect to industrial goods two dimensions are in the focus of such production processes, (i) the social dimension, and (ii) the environmental dimension.

(i) The social dimension includes occupational health and safety conditions, fair wage, or other measures for supporting very low income labor groups. If a production process is organized in a way that social standards are implemented, consumers might prefer this characteristic and would be willing to pay a higher price. Inclusiveness of all producing factors in the rents and benefits of technological change and globalization may be a valuable characteristic for a consumer's buying decision.

(ii) With regard to the environmental dimension consumers may have preferences for production processes consistent with sustainable environmental conditions. Thus they may be willing to pay a price for products that contain this characteristic.

The most critical problem for both dimensions is consumers' access to reliable information. The production process is a crucial part of the business and production concept of the firm an thus often hidden. Hence, it is very difficult for an individual consumer to get hold of such information. Since this information would promote an efficient choice of the consumer, collecting and providing this information is a public good. An instrument to provide such information would be a global and credible certification system. A reliable and hence credible global institution (public or private) would launch a certification system in value chains that could be certified as being "socially inclusive" or "environmentally sustainable".

8. Summary and Conclusion

Technological change is one, if not the most important, engine for economic progress and can be a powerful process that opens-up opportunities to increase social welfare and to deliver social benefits. The main concern in this context is whether all parts of society participate in the gains of technological change and hence, if the benefits are inclusively shared. Whether opportunities from technological change turn into real and inclusively distributable benefits for a society depends on a number of conditions. The belief that technological progress is always beneficial is only true in a world where only efficiency matters. On a political level, a substantial discussion has taken place over the past three decades on the need to raise 'efficiency' of national economies. However, social evaluations of a distributional outcome go beyond the criteria of pure efficiency, even if efficiency is important. Hence, as long as societies care about the distribution of income, an equitable allocation of benefits matters. In this light, our main focus is the question of inclusiveness for the global process of innovation and technological change. Our consideration includes asymmetric labor market effects and firm structure effects for the advanced economies as well as the channels of technological transfer from advanced economies to developing economies that allow these developing economies to participate in the benefits of technological change and the related economic and social development.

By introducing a conceptual framework of technological innovation, structural change and economic development as well as social inclusiveness we show that under second best conditions it depends on a society's decisions and regulations whether technological change leads to benefits for a sufficiently large number of people or favors only small groups. While the first scenario would be associated with inclusive growth the latter leads to more inequality and income disparity. Hence, if societies have any idea of what is an unjust income distribution, inclusiveness matters. Therefore, a discussion of technological change cannot be reduced to the issue that technological progress and innovation is the major source of income growth and structural change. It is important to ask who is able to benefit from this technology-induced process of structural change and growth and development. We focus the discussion on two major dimensions - technological innovation and the transfer of technologies - to elaborate the effects of technological change on world growth and development and the question of inclusiveness.

The first dimension, technological innovation that originates in advanced economies, is the driving force of per capita income growth. Technological change is skill biased and affects social inclusiveness while driving the overall growth process. The objective of firms to reduce labor costs and therefore to look for feasible, sufficiently inexpensive technologies to substitute low and medium skills is responsible for skill biased technological change in advanced economies. This skill biased technological change (SBTC) and the more recently discussed routine biased technological change (RBTC) has been a major cause of an asymmetric development of jobs and income in advanced economies. Furthermore, through trade and international integration labor market segments of different countries are linked together globally. Thus, according to the factor price equalization theorem labor groups in advanced economies implicitly compete with similar skill groups in developing countries and emerging markets. Driven by both elements, SBTC and the internationalization of production, we observe

a polarization of job growth towards low and high income jobs and a shrinking of the middle class in recent years.

Further, during the last three decades new technologies, in particular information technologies, also changed the structure of the firm and through this the extent to which different types of labor share the results of higher productivity. A change in the structure of the firm towards global value networks that organize a global value chain opens the chance of transferring technologies and know how towards developing countries.

Hence, the second dimension, the transfer of technologies to developing countries via direct transfer or imitation, is a substantial feature of globalization of trade and investment. Technological change affects all countries that introduce technologies new to their domestic production. 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. However, entrepreneurs in developing economies can only be inspired to search for opportunities, imitate international technologies and link up to global markets if the business environment in these economies is sufficiently encouraging. Among others, such conditions include appropriate human capital, infrastructure, and functioning institutions like the protection of property rights, low levels of corruption and political and macro-economic stability. As far as technology transfer by international integration is concerned not all trade is equally beneficial. Manufacturing trade is seen to be most beneficial in terms of promoting modernization and the modern sector, which is the key sector for sustainable development. This 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. The distribution of these rents determines, how inclusive this transfer of technology is. For a typical multinational enterprises (MNE as shareholder-firm) management and shareholders can be expected to gain from these rents. However, there are more agents, even outside the firm, who can channel rents into their own direction. Through corruption politicians and bureaucrats can participate in rent distribution. If corruption becomes too extensive and firms reduce their activities, the struggle for rents will even have a negative aggregate impact. Finally, a government can also influence technology transfer and rent distribution through its trade policy.

Moving the discussion of inclusiveness from a country level perspective to a global one, three major phenomena can be observed. First, total disparity measured by a global Gini coefficient has not changed dramatically. Second, in more detail 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. Third, 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.

Finally, we suggest policies including capacity building, promoting international market connectivity as well as functioning and expansion of domestic markets, the introduction of Cooperative Economic Zones (CEZ) and the implementation of independent, global certification of production and environmental conditions to give consumers a choice.

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