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Globalization, Structural Change and Innovation in Emerging Economies: The Impact on Employment and Skills

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Abstract

This paper aims to provide a critical overview of the drivers that the relevant theoretical and empirical literature suggests being crucial in dealing with the challenges an emerging country may encounter in its attempts to further catch-up a higher income status, with a particular focus devoted to the implications for the domestic labor market.

In the first part of the paper, attention will be focused on structural change, capability building and technological progress, trying to map - using different taxonomies put forward by the innovation literature - the concrete ways through which an emerging country can engage a successful catching-up, having in mind that developing countries are deeply involved into globalized markets where domestic innovation has to be complemented by the role played by international technology transfer.

In the second part of the paper, the focus will be moved to the possible consequences of this road to catching-up in terms of employment and skills. In particular, the prescriptions by the conventional trade theory will be contrasted with a view taking into account technology transfer, labor-saving technological progress and skill-enhancing trade.

Keywords: catching-up, structural change, globalization, capabilities, technological transfer.

JEL Classification: O14, O33.

1. Introduction

This paper is intended to provide a critical and updated discussion on some key issues that the relevant economic literature (both theoretical and empirical) suggests to be crucial in dealing with the challenges an emerging economy may encounter in its attempts to further catch-up a higher income status, with a particular focus devoted to the implications for the local labor market, both in terms of the level and the composition (skills) of domestic employment.

The first part of the paper will put forward an evolutionary interpretative framework that stresses the key role of dynamic capabilities, structural change and technological progress in fostering a development country's (DC henceforth) capacity to climb up the income ladder. In more detail, the conventional economic wisdom - ranging from the Lewis-Kuznets model to the endogenous growth approach - will be contrasted with the Schumpeterian and evolutionary views pointing to the roles played by structural change, human capital and knowledge, considered as key drivers for fostering catching-up and economic growth.

In more detail, the next section will start discussing the recent literature on the so called "middle income trap" (MIT henceforth), also giving account of the various possible solutions put forward by previous studies. Among the proposed escapes from the MIT, our focus will be centered on long-term structural strategies. In particular, in this section we will underline what the evolutionary approach considers the *condition-sine-qua-non* for triggering structural change, technological progress and eventually catching-up: namely, the availability of competences and capabilities able to maximize both the endogenous supply of knowledge by an emerging economy and its "absorptive capacity" of knowledge coming from more advanced economies.

Section 3 will focus on structural change and innovation, trying to map - using the taxonomies put forward by the economics of innovation literature - the concrete ways through which an emerging nation can engage a successful catching-up. As a matter of fact, knowledge, innovation and structural change do not come out of the blue (as mainstream economics tends to think), but must be implemented in a given economic system through concrete actions and specific channels.

While dynamic capabilities, structural change and innovation appear the most effective ways to foster catching-up, their possible impacts in terms of job creation and skills cannot be taken as granted, but may be rather controversial. Section 4 will be devoted to study the effects on domestic employment of what analyzed in the previous sections. An interpretative framework will be proposed and both the theoretical and the empirical literature on the subject will be critically surveyed. Having in mind that DCs are deeply involved into globalized markets where domestic technological change has to be complemented by the role (somehow much more important) played by international technology transfer, in this section the different channels through which the interlink between globalization and technological change affects domestic employment will also be disentangled and discussed in detail.

Section 5 will focus on the impact of globalization, technological transfer and structural change on the composition of local employment in terms of skills. In particular, the Heckscher-Ohlin-Stolper-Samuelson framework will be contrasted with an evolutionary view that takes into account technology transfer, labor-saving technological progress and skill-enhancing trade. As in the previous section, both the theoretical and the empirical extant literature will be critically discussed.

Finally, Section 6 will briefly summarize the main implications of what discussed and will put forward some policy suggestions.

2. Absorptive capacity, domestic competences and local dynamic capabilities as *conditio-sine-qua-non* for a successful catching-up

In this section, we will move from the very recent literature about the MIT to underline how this issue - so intensively debated by scholars and policy makers - can be better understood by an evolutionary approach focusing on absorptive capacity, domestic competences and local dynamic capabilities as pre-requisites for a successful catching-up.

Indeed, during the last decade a policy-relevant debate has arisen around the empirical observation that most of the emerging economies that managed to cross the middle-income threshold in the second half of the XX century have not yet been able to graduate into the high-income-countries club. This has been defined by Gill and Kharas (2007) as the “middle income trap” (MIT).

As a matter of fact, the concept of MIT is rather controversial from a theoretical point of view and there is even no accepted definition of the term by the relevant literature. For instance, Felipe *et al.* (2017) argue that claim that some middle-income economies do not advance is not confirmed historically, since the major economies today have spent many decades in traversing the middle-income segment. Rather than talking about a generalized MIT, the authors put forward the distinction between fast *vs* slow growing economies, a question that can be disentangled within the standard growth theory[1]. From another perspective, Doner and Ross Schneider (2016) claim that the MIT category has more to do with politics than with economics: according to the authors, today’s middle-income economies are different from their predecessors (the present richer countries) since they are characterized by institutional weaknesses (such as social fragmentation, higher degree of inequality and informality) which prevent them from investing in policies necessary to upgrade productivity, namely in education and innovation.

However, while the MIT category can be considered debatable from a theoretical perspective, empirically it can be considered as a starting point to discuss the possible patterns of catching-up by emerging economies which were able to escape from the underdeveloped status, but encounter some difficulties to further leapfrog into the club of the richer economies. In this section, far from fully support the theoretical concept of MIT, we just move from empirical considerations.

For instance, the World Bank (2012) concludes that out of 101 middle income countries in 1960, only 13 upgraded to the high-income category by 2008. Most of Latin America and all the MENA countries are examples of countries currently trapped in the MIT. In particular, several Latin American economies appear to be trapped over a long-term perspective, having failed to achieve high income levels despite attaining a middle income status several decades ago. By contrast,

[1] According to the economic growth theory, the process of development driving a low-income country into the middle-income group can be explained within a Lewis-Kuznets framework: during their initial stage of development, poorest countries can rely on the structural reallocation of labor from the low productivity sectors (mainly agriculture and traditional/personal services in rural areas) to high-productivity manufacturing, mainly located in the urban areas (see Kuznets, 1955; Lewis, 1955; Rostow, 1959; Kuznets, 1963; Kaldor ,1967; for a recent model revisiting this approach, see Grimalda and Vivarelli, 2010). However, this scenario substantially changes when countries that have revealed high growth potentialities in exiting from a low-income status, enter in a later stage of development. Indeed, when these countries reach the middle-income level, the pool of unemployed and underemployed rural workers drain out, wages start to rise, benefits from imitation and importing foreign mature technologies decrease in importance and capital accumulation starts to show decreasing returns and difficulties to grasp further scale economies (see Perez-Sebastian, 2007; Agenor and Canuto, 2012; Agenor et al. 2012).

several Asian economies (Japan *in primis*, the four Asian tigers later) are considered a kind of counter example, since they have continued to grow, thereby achieving per capita income levels comparable to OECD countries.

Similarly, Spence (2011) singled out the range between $5,000 and $10,000 per capita income as the stage of development where the transition to higher income levels becomes very problematic. In a more recent study, Eichengreen (2013) – searching for structural breaks applying the Chow test to a sample of formerly fast-growing middle income countries – have showed that the likelihood of sudden slowdowns is bi-modal having its peaks in the range of 10,000-11,000 constant US dollars at 2005 PPP and in the higher interval 15,000-16,000. This new evidence implies that a large group of middle income countries is at risk of being framed in a MIT.

From an interpretative point of view, it is important to notice that the literature points out that the growth slowdowns which signal the entering into the MIT are essentially productivity slowdowns rather than simply the consequence of decreasing returns in physical capital accumulation. In more detail, Eichengreen *et al.* (2012) estimate that 85% of growth slowdown is due to total factor productivity (TFP), while only 15% to capital accumulation. Daude an Fernandez-Arias (2010) got very similar results showing that TFP plays a key role in explaining the per capita income gap of Latin American and Caribbean countries, while differences in factor accumulation are shown to be substantially less important. These evidences point to the key roles of human capital, structural change and innovation as the main drivers of total factor productivity growth and so as possible solutions to the MIT (see Vivarelli, 2016).

In fact, the current literature has focused on the changing structure of the economy (diversification from low productivity sectors into high-productivity ones) and on the types of product exported as the most important drivers able to generate a possible way out from the MIT. Indeed, Hidalgo *et al.* (2007) and Hidalgo and Hausmann (2009) describe economic development as a process based on building capabilities and learning capacities that allow a country to produce and export more complex and sophisticated goods throughout a continuous process of diversification (that is entering into new sectors), product differentiation (that is to increase the variety and the characteristics of goods) and product up-grading (that is to improve the quality of the existing goods).

This framework has been applied to the MIT problem and several studies actually confirmed that these strategies can play a key role in escaping from the MIT. For instance, Felipe *et al.* (2012) compare the exports of countries in the MIT with those that managed to escape from it, using eight dimensions capturing country's diversification, sophistication of the export basket, potential for a country structural change and so on so forth (most of these indexes make use of the Balassa index of revealed comparative advantages, see Balassa 1965 and 1977; for a recent discussion, see Laursen, 2014). The authors found that the product profiles of the two groups are substantially different with countries escaped from the MIT (for instance, South Korea is studied in details) having more diversified, sophisticated and non-standard export baskets at the time they were about to make the jump. By the same token, Jankowska *et al.* (2012) applied a "product space" approach to a sample of Latin American and Asian countries, estimating the impact of both diversification into new sectors (extensive, widening strategy) and of increasing a country's export share in current highly sophisticated sectors (intensive, deepening strategy). The authors found that, although all countries managed to increase the number of industries in which they reveal a comparative advantage (measured through the Balassa index), significant differences in the evolution of the countries' product spaces emerge, with country like Korea standing out and others like Brazil and Mexico lagging behind. Finally, Eichengreen *et al.*, (2013) found that high-tech exports (both manufacturing goods and services) significantly reduce the likelihood of growth slowdowns (together with high quality human capital)

On the whole, the (mainly empirical) literature on the MIT implicitly suggests the roles of capabilities, structural change and technological progress as the key factors able to better positioning a middle income country in front of the challenges posed by the risk to enter into a MIT. Nevertheless, this literature fails to go beyond these empirical suggestions and lacks a proper theoretical framework. In other words, being either not-theoretical or inspired by the conventional economic theory of trade, this literature sees the problem and grasps some possible solutions but fails to provide a fully-fledged interpretative framework, able to generate feasible and effective policy suggestions. Indeed, in their paper taking stock of ten years of debate about the MIT, Gill and Kharas (2015) claim the absence of a satisfactory economic growth theory ("trap of ignorance" ibidem, p.4), able to help policy makers in middle income countries to figure out an effective road to speed up the transition to a higher income status (ibidem, p.20).

For this purposes, the focus should move to an evolutionary framework that - differently from what discussed so far and from most of mainstream approaches – is able to go inside the concepts of absorptive capacity, dynamic capabilities, structural change and innovation. Indeed, albeit recognizing their roles, the mainstream literature considers these key variables as "exogenous" (something like "manna from heaven"), invoking them but avoiding to explicitly discuss the ways how capability building, structural change and innovation (and their interactions shaping a proper co-evolving "match") can actually take place in a developing economy engaged in catching-up.

First of all, it has to be clarified that the MIT is not an empirical/unavoidable phenomenon, but something strictly connected with a productivity gap (see the evidence discussed above) and so, in turn, to technological and structural change.

On the one hand, even mainstream macroeconomists have recognized the crucial role of technological change. In more detail, the so-called "endogenous growth" models have singled out the accumulation of R&D as one of the main sources of long-term economic growth (see Mankiw *et al.*, 1992; Romer, 1994; Lucas, 2002). In this respect, several studies state that R&D expenditures represent the main engine of increasing productivity and economic growth (see Nelson and Winter, 1982; Aghion and Howitt, 1998; Ortega-Argilés *et al.*, 2014; Mohnen and Hall, 2013).

On the other hand, mainstream economics looks at innovation as a kind of externality which, basically through R&D spillovers, can positively affect productivity and eventually economic growth. In contrast, later in this paper, we will put forward concepts and taxonomies able to look at technology as a genuinely endogenous phenomenon (see Section 3) that can be shaped by investment decisions (both private and public) and by deliberate public policies, with particular reference to industrial and innovation policies (see also Section 6).

Indeed structural and technological change (in general and particularly in a DC) is neither "manna from heaven" nor the simple consequence of magic spillovers "floating around the air"; in contrast, structural and technological change need a proper "terrain" to develop their own potentialities and ultimately foster productivity growth. To prepare this terrain is the very first challenge a given DC has to face in order to deal with the MIT and engaging in a successful catching-up (see Fagerberg, 1994; Fagerberg and Godinho, 2005).

In fact, given that R&D and innovation are the main drivers of diversification, productivity growth and eventually economic development (see above), one can wonder whether different countries have the same possibilities to domestically produce new knowledge and to absorb the external knowledge, available at the international level. The answer is that this is not the case at all: indeed, countries have different degrees of capabilities in developing new knowledge and even in taking advantage from using the same internationally available technology. The reason is that country-specific structural conditions and "social capabilities" may cause 'incongruences' with respect to a certain basic knowledge and/or applied technology (see Abramovitz, 1986 and 1992): given the same available technologies, only those countries endowed with adequate social capabilities can properly master the new technological opportunities, exploit them in a competent way and ultimately successfully engage a catching-up pattern of growth (see Sutton, 2012).

Moreover, capabilities and cumulated former knowledge are essential in fostering the so-called 'absorptive capacity', that is the ability to exploit further external technological opportunities (see Mowery, 1983; Pavitt, 1984; Cohen and Levinthal, 1989 and 1990; Rosenberg, 1990; Rosenberg, 1994).

It is important to note that capabilities are crucial not only on the technological frontier (that is to cope with the challenges common to the advanced countries), but as well as in the catching-up (that is the challenge common to DCs). In this framework, capabilities can be considered pre-requisites to allow a middle income country to avoid the MIT and to enter a successful pattern of growth. Indeed, as it will be extensively discussed later in this paper, DCs rely less on domestic innovation rather than on the absorption of knowledge developed elsewhere (typically in richer countries and in multinational firms located within the country). If such is the case, the presence of strong domestic competences and capabilities becomes a key factor for a long-term strategy addressed to overcome the MIT (see Lall 1992 and 2004)[2].

In this context, differences in the capacity of building adequate dynamic capabilities may well explain the divide between countries that managed to escape from the MIT and countries that did not (think, for instance, to the role of education, training and learning in Japan in the '60s and '70s, Toyota being the most studied case, see Freeman, 1987)[3].

From this point of view, adequate and updated competences and capabilities emerge as core assets for expanding the "product space" and increasing productivity, so escaping from the MIT (see the discussion in the first part of this section).

In this framework, education and training policies can be considered a *conditio-sine-qua-non*, in order to acquire a sufficient "absorptive capacity" able to make value from the available knowledge

[2] The crucial distinction between competences and capabilities is discussed by Von Tunzelmann and Wang (2003 and 2007; see also Iammarino *et al.* 2012). Competences are understood as pre-set attributes of individuals, firms and organizations: competences are typically provided by the education and training systems and acquired through labor mobility. For example, one may think of firm's endowment of adequate skills as the necessary internal competences to obtain value from innovation investments (see Piva and Vivarelli, 2009b). Capabilities instead involve both internal and external learning and accumulation of new knowledge on the part of individuals, firms and organizations (see Bell and Pavitt, 1995; Hobday, 1995). Consequently, capabilities must be considered as the results of an adaptive learning process and so they are intrinsically "dynamic" (see Teece et al., 1997). Moreover - since capabilities are dynamically accumulated trough a continuous upgrading of new competences and through learning (see Arrow, 1962; Malerba, 1992; Dosi and Nelson, 2013) - they show increasing returns and dynamic scale economies: more sophisticated are your initial competences, more you learn, more you can absorb external knowledge, and more capabilities you can accumulate in the long-run.

[3] Different endowments of dynamic capabilities can also explain relevant differences among regions within the same DC. Indeed, particular regions within middle-income countries have revealed to better exploit cumulative learning and the emergence of a knowledge critical mass able to make value from locally developed dynamic capabilities (see, for instance, the state of Bangalore in India).

worldwide and trigger a further development of local dynamic capabilities (see Lall, 1992 and 2004). In contrast, trying to leapfrog into knowledge economies lacking proper capabilities and absorptive capacity could be very risky, since a DC trying to prematurely engage in technological upgrading and catching-up might easily be doomed to fail.

Here again, the experience of those Asian countries that were able to overcome the MIT is illuminating: their massive investment in education and their consequent strong endowment in terms of skills and competences were the strong bases on which they started to accumulate those dynamic and collective capabilities which eventually allowed them to successfully catch-up richer economies. Indeed, evolutionary economists look at domestic capabilities - rather than market comparative advantages - as the basic endowments on the basis of which a developing country can engage a catching-up pattern of growth (see Dosi, *et al.*, 1990; Cimoli *et al.*, 2009; Vivarelli, 2016).

However, the availability of competences and collective dynamic capabilities is a necessary but not sufficient condition for engaging into a successful catching-up and fostering a long-term productivity growth. In this respect, attention has now to be turned to the actual dynamics of technological progress, considered in its interaction with structural change.

3. Technological taxonomies and the key role of innovation

This section moves from the assumption that an emerging economy country had already successfully built the preconditions for catching-up, in terms of competences and capabilities, as discussed in the previous section. Given this context, this section recalls and discusses different technological taxonomies which can be of some help in figuring out the specific trajectories a DC can engage in order to successfully catch-up.

In other words, if a DC is "ready" to engage into technological progress and structural change (see the previous section), we have now to make clear how these changes develop and which are the strategies a catching-up country can play in order to maximize its benefits from structural change and innovation. Here again, we depart from conventional mainstream economics, which consider technical progress as "manna from heaven" and refer to that innovation literature that - starting from Schumpeter (1934, 1942) - has been able to endogenize technology in studying its intrinsic nature, drivers and consequences.

A first important stream of literature related to the drivers of innovation activity is represented by the demand-pull *vs* technology-push taxonomies.

Since Schmookler's (1962) seminal contribution, many authors have tested the hypothesis that demand drives the rate and direction of innovation. In this line, various theoretical and empirical approaches, both at the aggregate (see Schmookler, 1966; Scherer 1982; Kleinknecht and Verspagen, 1990; Geroski and Walters, 1995) and at the microeconomic level (see Brouwer and Kleinknecht, 1996 and 1999; Piva and Vivarelli, 2007 and 2009a) agree to consider demand and market growth as essential factors for boosting innovation activity based on increasing returns of scale, optimistic expectations and diminishing cash constraints.

In this context, an emerging economy engaged in catching-up should carefully take into account the internal and external sources of demand for local products, having in mind that structural change and innovation can be driven by demand evolution (for instance through an "export-led" dynamics).

However, it is obvious that the technological content of "demand-pulled" innovation may substantially vary according to the specific sectoral/product development induced by a boosting demand (see Cimoli *et al*., 2010): in other words, the innovation consequences of an increase in the world/domestic demand for commodities would be different from an increase in the world/domestic demand for ICT-related products or for biotech products.

At any rate, structural change and technological progress are not only a market-driven phenomena: indeed, economic agents and policy makers may "push" technological advances and deliberately address the goal of increasing the rate of technological progress. In this context, innovation does not depend only on market signals (such as demand evolution or production factors prices) but is characterized by its own rules of development, as described in the well-known "*technology-push*" hypothesis. The first comprehensive discussion of this hypothesis was put forward by Mowery and Rosenberg (1979): their core idea is that the rate and direction of technological change is basically affected by advances in science and technology and by the availability of exploitable 'technological opportunities' (see Klevorick *et al*., 1995).

If such is the case, catching-up countries should aim to conquer higher degrees of freedom in foster domestic innovation; far from being passive in front of an exogenous international division of labor that forces countries' sectoral and technological specialization, local public authorities and private economic agents should become active actors in pushing technological advances and consequent catching-up. These activities include public and corporate R&D investments; industrial policies supporting structural change in favor of the R&D-intensive sectors; public support to science and education; development of appropriate technological infrastructures; IPR regulation; university spin-offs; and so far so forth.

In this context, for a DC the choice is between a passive acceptance of the role assigned (worldwide) by comparative advantages, market forces and relative prices and a more active attitude aiming to participate to the shaping of the current technological trajectory (see Dosi, 1982 and 1988) through massive investments in knowledge activities (technology-push), and through selective and targeted demand-pull policies favoring sectoral diversification and product differentiation (see Cimoli and Dosi, 1995; Cimoli *et al*., 2009). In this perspective, those DCs that will be able to play an active role in the prevailing technological trajectory will grow, while the others will remained trapped in something that it is not unavoidable, but strictly determined by the lack of those technology-push and demand-pull strategies able to foster a further technological and economic catch-up of the more advanced economies. Think, for instance, to the contrasting specialization of the middle-income-trapped Latin American countries vs the Asian emerging economies: commodities on the one hand vs electronics and other high-tech sectors on the other hand (see Garrett, 2004; Cimoli and Porcile, 2009; Felipe *et al*., 2014).

An example of an active long-term strategy can be proposed using the well-known Pavitt's taxonomy (Pavitt, 1984)[4]. Having in mind the discussion above, a DC should actively search for original solutions to climb-up the technological and sectoral ladder moving from the "supplier

[4] Overcoming the conventional distinction of economic activities based on products, Pavitt put forward a framework where manufacturing firms are aggregated on the basis of their technological characteristics: 1) "science based firms" that are R&D intensive, strictly connected with science (universities and scientific laboratories) and more prone to radical product innovation (think for instance to pharmaceutical and microelectronic firms); 2) "specialized suppliers" that are also R&D intensive and devoted to introduce new and better quality products (think to advanced machineries); "scale intensive firms" that are mainly devoted to cost-cutting process innovation (think to large "fordist" firms such as car factories); 4) "supplier dominated firms" belonging to traditional sectors such as agriculture, textile and clothing and introducing process innovation through the embodied technological change incorporated in machineries and components bought from firms belonging to the other three categories.

dominated” category up to the scale intensive and specialized supplier ones and eventually – at least in some scientific niches – to the science based one. Indeed, the Asian countries which were able to escape from the MIT (first of all Japan in the ‘60s and ‘70s) are exactly those countries that managed to move up from a supplier dominated situation (with a dominant specialization in agriculture, traditional manufacturing sectors and non-tradeable basic services) to a much more diversified specialization characterized by a leading role of scale intensive firms (think about the automotive industry in Japan and South Korea), specialised suppliers (think about numerically controlled machineries in Japan) and eventually science-based firms (think about the role of microelectronics in Japan and all the other Asian NICs; see Amsden, 2001).

Extending Pavitt’s taxonomy, Marsili (2001) and Marsili and Verspagen (2001 and 2002) have proposed a further taxonomy singling out five sectoral regimes (see Winter 1984; Malerba and Orsenigo, 1995 and 1996): 1) the “science based regime”, where knowledge is based on advances in science, technological entry barriers are high, innovation is highly cumulative and mainly generating product innovation (examples being the pharmaceutical and the micro-electronic industries); 2) the “fundamental-process” regime, which displays a medium level of technological opportunities, (examples being the chemical and oil industries); 3) the “complex (knowledge) system” regime, where medium-high technologies are implemented in productions affected by important scale economies (examples being the aerospace and motor vehicle industries); 4) the “product-engineering” regime, where medium technologies are adopted in a context where innovative entry barriers and technological cumulativeness are relatively low and innovation is mainly of the product type (examples being the machinery and instruments sectors); 5) the “continuous-process” regime, where low technologies couple with low technological entry barriers, low persistence of innovation and a dominant role of embodied technological change and process innovation, (examples being traditional manufacturing sectors like textiles, clothing, paper and printing, food and beverages).

More recently, Bogliacino and Pianta (2010) have put forward an extension/revision of the Pavitt’s taxonomy, able to fully take into account services. They did it on the basis of conceptual considerations and evidences coming out from the European Community Innovations Surveys (CIS). In more detail, knowledge intensive services (KIS) such as communications, research and development and software have been incorporated into the science-based group. Differently, real estate, renting of machinery and other business activities providing specialised activities that support specific needs of customers have been assimilated to the specialised suppliers group. Turning the attention to the financial and insurance services characterized by large firms and an extensive adoption of ICT, they have been classified as scale and information intensive industries (see also Tidd *et al.*, 2005). Finally, traditional low-tech services such as wholesale and retail trade, hotels and catering and all the transport services - that exhibit very limited internal R&D and mainly rely on innovations provided by their suppliers - have been included in the supplier dominated group.

Finally, Lee (2013) puts forward a distinction in terms of technologies, where “short-cycle” technologies are contrasted with “long-cycle” ones, the former being characterized by a higher and faster rate of product and process turnover (measured by the author using patent data). Obviously enough, in a certain time the two types of technologies can be related to specific sectors, given the link between technological change and structural change. On the other hand, over time, a given sector may be characterized by one or the other type of technologies, according to the different phases of its “industry life cycle” (see Klepper 1996 and 1997).

On the whole, all the taxonomies discussed so far are clearly pointing out that "innovation" is not a homogeneous (strictly exogenous for many mainstream economists) phenomenon and should be understood in its deep interlinks with an economy sectoral structure. In other words, structural and technological change should be considered as highly interrelated and co-evolving. In particular, an emerging economy eager to grow should address its technology investments and policies, taking into account the heterogeneity and sectoral peculiarities which characterize the intrinsic nature of innovation. In this respect, the role of the State and of the government intervention is obviously crucial (see Lee, 2013; Jun-Youn et al., 2013).

For instance, the process innovation embodied in capital goods imported by richer countries (see Section 4.2 below) may have an important role in sustaining the upgrading of those traditional sectors belonging to the "continuous-process" regime, but it is unlikely that it may play a key role in fostering structural change in terms of diversification and expansion of the product space (see Section 2). In contrast, attracting high-tech FDI and especially multinational R&D labs (see Section 4.4 below) may be of fundamental importance in the take-off of "science based regime" sectors.

Having these considerations in mind, domestic policies in the DCs should be carefully shaped, targeted and tailored in order to maximize the benefits of the interaction between structural and technological change. Exactly the opposite scenario occurs when an emerging country passively accepts to be embedded in a trap where international specialization, market forces through relative prices and technological inertia (path-dependency) constrains it into a static situation, where further economic growth is prevented by the lack of long-term strategies affecting both its sectoral structure and the domestic supply and demand of new technologies[5].

In other words, emerging economies should not pursue their development on the basis of their static "comparative advantages", but rather engage into long-term strategies addressed to achieve "absolute advantages" (see Dosi *et al*., 1990). In this respect, once again the Asian experience can be opposed to the Latin American one where most of the economies are still focusing on commodities and other supplier dominated ("continuous-process" regime) sectors, with very few attempts of structural and technological diversification towards the specialized-supplier and the science-based sectors (Brazil being a partial exception; see Cimoli and Porcile, 2009). Indeed, Cimoli *et al*., (2010) provide convincing evidence showing that the DCs that succeeded to escape from the MIT were those that were able to transform their industrial structure in favour of the high-tech and higher demand elasticity sectors. More specifically, Lee (2013) has shown that successful catch-up countries like Korea and Taiwan (and probably China in current times[6]) were able to targeting technologies (and the related sectors, see above) with shorter cycle times, as the ICT. In doing so, these middle income countries were able to exploit "windows of opportunities" where the dominance of the incumbent richer countries could be successfully challenged (see Lee and Malerba, 2017). If emerging economies adopt these strategies (implemented by both by private companies and by government intervention), they not only avoid any risk of MIT, but may eventually leapfrog into new and emerging industries previously dominated by the sole advanced countries[7].

[5] With regard to what discussed in Section 2, the MIT is not an unavoidable outcome; having in mind the taxonomies discussed in this section, a middle income country can put forward a long-term strategy where tailored policies can be shaped on the basis of the different sectoral characteristics and where the same sectoral structure of the economy is not assumed as given but becomes itself a policy target (for instance, a DC may pursue the aim to gradually escape from the "continuous-process" regime in favor of the other four regimes discussed above).

[6] Although rising income inequality may prevent China from reaching a proper social cohesion, which is also a pre-condition for a successful catch-up (see Islam, 2015).

Obviously enough, acquiring competences and capabilities (see previous section) and moving up through the technological ladders set up by the taxonomies discussed in this section are two interrelated phenomena.

On the one hand, adequate competences and capabilities are pre-requisites to enter that structural change that allows a country to move to a high-tech specialization (science-based, specialized suppliers and scale and information intensive sectors in Pavitt's and Bogliacino-Pianta's terminology; science based, complex and product-engineering regimes in Marsili's terminology; short-cycle technologies in emerging industries in Lee's terminology); to fully exploit the options for differentiation and diversification (see Nübler, 2014); and to expand the product space jumping into sophisticated goods (see Section 2).

On the other hand – since capabilities are "collective" and "dynamic" and shaped by a continuous process of learning and accumulation of new and updated knowledge – moving into more advanced regimes provides those learning and technological opportunities which substantially increase the possibilities of acquiring new competences and capabilities and diffusing the ones already available within a country. From this point of view, advanced capabilities and high-tech regimes should be understood as interactive, co-evolving and mutually accelerating drivers of a long-term strategy for catching-up.

4. The impact on domestic employment

From what discussed so far, we can conclude that technological change, in turn based on local capabilities and embedded into structural change, is the key driver of catching-up. However, DCs have to rely massively on international technology transfer to have access to knowledge; this means that technological progress, structural change and globalization are strictly interlinked from an emerging economy's perspective.

As mentioned in the introductory section, the second part of this paper will be devoted to investigate how globalization and technological upgrading may impact the local labor market both in terms of level of employment (this section) and the composition of domestic employment in terms of skills (next section). Indeed, while technical progress appears crucial for growth and for escaping the MIT (see previous sections), its consequences in terms of employment and skills may be controversial and may originate negative social counter-effects, as we will see (see Stiglitz, 2002).

Here below the possible impact of technological upgrading on domestic employment is discussed in relation to the different channels through which a DC can climb the technological ladder.

4.1 Domestic technologies

[7] Obviously enough, this approach calls both for an active role of economic policy and for the possibility to foster "targeted jumps" in economic development; therefore, this theoretical framework is in sharp contrast both with a view just focused on the "right" institutional setting providing an adequate structure of private incentives (see Acemoglu and Robinson 2012), and with a view advocating a gradualist economic growth rigidly based on a sequence of well-defined development stages (see Lin, 2011; Wang and Wen, 2018).

The first vehicle for technological upgrading is obviously based on domestic investment in R&D and innovation (both public and corporate), a structural change favoring those sectors belonging to the most advanced categories within the taxonomies discussed in the previous section and a targeted innovation policy supporting both technology-push and demand-pull innovation (see again the discussion in the previous section).

However, technological progress is driving productivity increase, in turn implying the possibility to produce the same amount of output with less workers. This means that technological upgrading can be surely beneficial for a DC's catching-up (see previous sections), but may also be detrimental for domestic employment.

Indeed, the conventional wisdom in mainstream economic theory states that technological unemployment is a temporary circumstance, which can be automatically compensated by market force mechanisms that counter-balance the initial job losses. These mechanisms came to be known as the "compensation theory", using the terminology presented by Karl Marx in his discussions on large-scale industry and the introduction of machinery (see Marx 1961: Chap. 15). Six compensation mechanisms work to offset technology's labor-saving effects through: (1) additional employment in the capital goods sector where new machines are being produced, (2) decreases in prices resulting from lower production costs on account of technological innovations, (3) new investments made using extra profits due to technological change, (4) decreases in wages resulting from price adjustment mechanisms and leading to higher levels of employment, (5) increases in income resulting from redistribution of gains from innovation, and (6) new products created using new technologies (for extensive analyses, see Vivarelli, 1995, chaps. 2 and 3; Petit, 1995; Vivarelli and Pianta, 2000, chap. 2; Simonetti, Taylor and Vivarelli, 2000; Piva and Vivarelli, 2004a and 2005; Pianta, 2005; Vivarelli, 2013).

However, measuring the extent and actual effectiveness of these compensation mechanisms and assessing the final quantitative impact of technology on overall employment is not a straightforward exercise and has long been a subject of a controversial debate among economists (for detailed surveys, see Vivarelli, 2014 and Calvino and Virgillito, 2018). In particular, low demand and capital/labor substitution elasticities, attrition, pessimistic expectations and delays in investment decisions may involve that compensation can only be partial.

In fact, compensation mechanisms can be hindered – or even annihilated - by the existence of important market failures and institutional drawbacks. For instance, labor-saving technologies can spread around in the capital goods sector as well, so limiting the power of the compensation " via new machinery"; moreover, the new machines can be implemented simply by substituting the obsolete ones (scrapping), involving no compensation in jobs. Similarly, the effectiveness of the mechanism "via decrease in prices" depends on the hypothesis of perfect competition and on the value of the demand elasticity (see Sylos Labini, 1969, p. 160). By the same token, the compensation mechanism “via new investments” also relies on the strong assumption that the accumulated profits due to technical change are entirely and immediately translated into additional investments, while it should be taken into account that the economic agents’ expectations can imply a delay in the translation of additional profits into “effective demand” (see Pasinetti, 1981). Moreover, the intrinsic nature of the new investments does matter; if these are capital-intensive and labor-saving, compensation will be particularly limited. Also the mechanism “via decrease in wages” is controversial: on the one hand, a decrease in wages can induce firms to hire additional workers, but - on the other hand - the decreased aggregate demand lowers the employers’ expectations and so they tend to hire fewer workers. Finally, albeit new products can be considered the more powerful way to counterbalance labor-saving process innovations, different “technological paradigms” (see Dosi, 1982; Dosi and Nelson 2013; see also Section 3) are characterized by different clusters of new products which in turn have very different impacts on employment .

Turning the attention to the empirical studies on this subject, the extant literature has pointed out that R&D expenditures[8] and product innovation tends to be labor friendly, while process innovation reveals to be labor-saving; moreover, the job-creating effect of innovation is far more obvious in high-tech sectors and new services rather than in low-tech manufacturing and traditional services (for recent studies see Bogliacino and Pianta, 2010; Lachenmaier and Rottman, 2011; Bogliacino and Vivarelli, 2012; Bogliacino, Piva and Vivarelli, 2012; Feldmann, 2013; Falk and Hagsten, 2018; Piva and Vivarelli, 2018).

As a matter of fact, the debate on compensation mechanisms and their functioning has often taken place within the context of developed countries. Obviously enough, the validity of the compensation theory becomes even more questionable in DCs, where process innovations dominate product innovations and where agriculture, mature manufacturing sectors and traditional services represent the bulk of their economic structure.

In more detail, when “total factor productivity” increases in a DC as a consequence of imported (see next section) and domestic technologies, the employment enhancing competitive effect has to be compared with the direct labor-saving effect of such technologies (see Vivarelli, 1995; Coe et al., 1997; Mohnen and Hall, 2013). The final outcome cannot be assessed a priori. On the whole, as discussed in Taylor (2004), the final employment outcome depends on the balance between labor productivity gains and output growth. Consistently, in determining the final employment outcome, the effectiveness of price and income compensation mechanisms and their possible drawbacks discussed above are obviously crucial in the particular case of DCs, as well (see Hall and Heffernan, 1985). As a matter of fact, the empirical studies on the relationship between domestic technologies and employment in emerging economies are extremely scarce. However, a previous recent work by the author of this paper (with co-authors) seems to suggest a labor friendly impact of domestic R&D expenditures in the particular case of Turkish manufacturing (see Meschi et al., 2016).

[8] Indeed, R&D expenditures are more strictly related to product innovation rather than to process innovation (see Conte and Vivarelli, 2014).

This means that emerging economies aiming to minimize the possible labor-saving effects connected with technological upgrading should rely on a catching-up based on product innovation and to a structural change addressed to the new and emerging sectors and not at all on the initial comparative advantages in agriculture, commodities and traditional manufacturing industries (as prescribed by the conventional mainstream trade theory) since these sectors are exactly those more prone to labor-saving process innovation.

4.2 Imported technologies and FDI

As a matter of fact, emerging economies have generally limited endogenous capabilities and knowledge (see Section 2) and limited resources to devote to domestic R&D. Therefore, they have to mainly rely on international technology transfer. In other words, a large portion of technological change in a DC is inherently connected with trade, foreign direct investments (FDI) and consequent international technology transfer (see Acemoglu, 2003; Piva, 2003; Keller, 2004). Therefore, for an emerging economy technological upgrading and globalization are strictly interlinked.

In this framework, it is relevant to map the different channels through which globalization can act as a provider of new knowledge for an emerging economy and their likely impacts in terms of domestic employment.

It is interesting to notice that the traditional (mainstream) trade theory has a clear answer to this research question. Indeed, according to the theory of the relative comparative advantages, both trade and FDI should take advantage of the abundance of labor in DCs and so trigger a trend of specialization in domestic labor-intensive activities, in turn surely involving an expansion in local employment.

However, contrary to this classical Heckscher-Ohlin (HO) prediction, the analysis of the recent literature supports the conclusion that the employment impact of increasing trade and FDI is not necessarily positive for a DC. In particular, a relaxation of the hypothesis of homogeneous production functions across different countries[9] allows for the possibility of multiple equilibria (Grossman and Helpman, 1991). In particular, since richer countries are more technologically advanced than DCs, trade and FDI imply technology transfer and this may likely be labor-saving compared with traditional technologies in use within DCs, so reversing the traditional (static) HO prediction.

In more detail, increasing globalization favors technological upgrading by increasing the international flows of capital goods, especially machineries (see Acemoglu, 2003). Indeed, there is much literature that finds that import and FDI inflows can in fact contribute to the technology transfer by providing DCs' local firms access to new embodied technologies and by creating opportunities for reverse engineering. In other words, the inflow of capital goods allows a DC to take advantage from the "embodied technological change" (ETC) incorporated in machineries and components[10].

[9] That is to admit the obvious evidence that technologies are different across countries.

[10] Obviously enough, the receiving DC must possess the adequate capabilities and a proper industrial structure (see Section 2) to allow an effective implementation of the imported technologies. If such is the case, the impact in terms of technological upgrading, productivity increase and ultimately economic growth can be substantial. For instance, Coe and Helpman (1995) and Coe et al. (1997) find that foreign knowledge embodied in traded goods has a statistically significant positive impact on aggregate TFP in importing countries (either OECD countries or DCs). Focusing on DCs only, Mayer (2000) restricts the definition of import shares by considering only machinery and finds that in this case the

However, as mentioned above, the other side of the coin of the productivity increases linked to the import of capital goods may be a harmful effect in terms of domestic employment (especially the low skill manpower in traditional activities, see also next section). Indeed, ETC is driving process innovation and this type of technological progress may be drastically labor-saving and only partially counterbalanced by the compensation mechanisms briefly discussed above (see Section 4.1).

In this framework, it is important to underline that an emerging economy can receive knowledge through a wide range of products. On the one extreme, it can take advantage from the importation of "mature" machineries (including second-hand capital goods, see Barba Navaretti *et al*., 1998) from more industrialized countries. On the other extreme, a DC with good absorptive capacity and adequate domestic capabilities (see Section 2) can enjoy the "last comer" benefit of jumping directly on a relatively new technology (what Gerschenkron, 1962, labelled as the "benefit of backwardness"; see also Perkins and Neumayer, 2005); an example being the diffusion of mobile telecommunications in DCs where the traditional telephone networks are limited to few urban areas. Obviously enough, the employment implications of the two sketched situations are very different.

Shifting our focus from trade to FDI inflows, when a developing country opens its borders to foreign capital, FDIs generate positive employment impacts both directly and indirectly through job creation within suppliers and retailers and also a tertiary employment effect through generating additional incomes and so increasing aggregate demand (see Lall, 2004).

Nevertheless, all these positive employment effects of "greenfield" FDI have to be compared with the possible crowding-out of non-competitive and previously sheltered domestic firms (implying bankruptcies and job losses); with the possible labor-saving effects of the new technologies brought about by multinational firms; and with the possible reduction in employment associated with FDI operating through M&A and "brownfield" plants (see Spiezia 2004).

As a matter of fact, both imports and inward FDI may imply a "crowding out" of domestic production (especially formerly protected nascent industries; think, for instance, to the case of the large urban state-owned firms in China, see Rawski, 2002; see also Aitken and Harrison,1999).

However, if the host DC is able to offer a proper industrial structure (see the taxonomies discussed in the previous Section 3) and a pool of adequate competence and capabilities (see Section 2), a foreign firm can opt for a high technology FDI ("asset augmenting" attitude), rather than an "asset exploiting" type of FDI (see Moncada-Paternò-Castello et al., 2011 and Section 4.4 below). If such is the case, greenfield investments and product innovation should lead to beneficial employment effects.

Therefore, in terms of employment impact, the final outcome of trade and FDI may be very diverse. On the one hand imported ETC implemented in low-tech firms as well as brownfield FDI in traditional sectors are likely to be detrimental for domestic employment. On the other hand, imported capital goods used in fostering emerging sectors as well as greenfield FDI in high-tech sectors are characterized by fast growing perspectives and product innovation and so likely turning out to be labor-friendly.

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impact of foreign R&D is much greater. Similarly, Barba-Navaretti and Solaga (2002) look at the role of imported machinery in transferring embodied technological progress, focusing on the imports of machines from the EU to a sample of neighboring developing and transition countries in Central-Eastern Europe and in the Southern Mediterranean; they find that imported machinery has a positive impact on total factor productivity and that the impact is greater the higher the technological complexity of the imported machinery.

Empirically, very few studies have investigated the link between imported technologies, FDI and local employment in DCs. Among them, Meschi et al. (2016) find a labor-friendly impact of FDI in Turkish manufacturing, while Haile et al. (2017) find a similar result with regard to manufacturing employment in Ethiopia (although less significant in statistical terms). On the other hand, Conte and Vivarelli (2011) do not find a significant labor-saving impact of imported technologies in a panel of 23 DCs (rather, they find a labor-friendly impact, although limited to the high-skilled workers, see Section 5 below).

4.3 Learning by export

Breaking into foreign markets allows firms originally operating only domestically to acquire knowledge of international best practice (the so-called "learning by export" hypothesis).

On the one hand, foreign buyers often provide their suppliers with technical assistance and product design in order to improve the quality of imported goods, and they may transmit to their suppliers located in DCs the tacit knowledge acquired from other suppliers located in advanced countries (Epifani, 2003). For instance, Newman *et al.* (2013) found convincing evidence that the export of intermediate goods may be a source of backward technology transfers that in turn can lead to productivity gains for domestic producers[11].

Moreover, Verhoogen (2008) argues that trade leads to an upgrading of average product quality in exporting plants; in particular, he finds that the "quality-upgrading hypothesis" is relevant for a middle income country such as Mexico. This idea is also pursued by Fajnzylber and Fernandes (2009) studying Brazil - who point out that exporters may be pressured by their foreign clients to produce according to quality standards that are higher than those prevailing in the domestic market.

In sum, technological catch-up may be induced by exporting to richer countries both through substituting/replacing outdated technologies in the exporting sectors and through the development of entirely new businesses characterized by product innovation addressed to satisfy a more sophisticated demand coming from the richer countries (see Keller, 2004).

Obviously enough, this particular channel of technology transfer may be positive in terms of local employment, since it can be connected with the production and diffusion of new products or even with the emergence of sectors previously absent in a given DC. In terms of the compensation theory discussed at the opening of this section, the kind of technological upgrading connected with this channel of internationalization appears unbalanced in favor of both product innovation and the labor-friendly compensation mechanisms based on increasing demand and additional investments[12].

4.4 R&D outsourcing

Finally, technological up-grading can occur in a very direct way through the outsourcing of knowledge intensive activities – such as R&D labs – from richer countries to emerging countries.

[11] Consistently, Yeaple (2005) shows that increased export opportunities make the adoption of new technologies profitable for more firms. Bustos (2005) builds a model upon the works of Yeaple (2005), while Melitz (2003) argues that trade liberalization reduces variable export costs and makes adoption of new technologies profitable for more firms.

[12] The limited empirical evidence on the subject seems to confirm a positive employment impact of export-led activities (see Meschi *et al*., 2016; Haile *et al.* 2017).

Although relatively recent and still limited , this phenomenon is fast growing and implying obvious and relevant effects on the capability building capacity, the productivity evolution and ultimately the economic growth of the host DC (see Moncada-Paternò-Castello *et al.*, 2011).

Indeed, over the last two decades, the international re-allocation of the global value chain has increasingly shifted towards the 'unbundling' of activities previously vertically integrated and locally concentrated (see Hummels *et al*., 2001; Hanson *et al*., 2005; Helpman, 2006; Rugman *et al*., 2010). Nowadays, this unbundling trend also concerns knowledge intensive activities – such as R&D and innovation - which were previously considered 'core activities' to be retained by companies' headquarters (see Grossman and Helpman, 1991; Florida, 1997; Chung and Yeaple, 2008)[13].

From an empirical perspective, a survey presented by the EIU (2004) revealed that when managers were asked where they would spend the most on R&D in the next three years, two emerging countries stood out: China and India (39 % and 28%, respectively). More specifically, an UNCTAD (2005) survey of the largest R&D spenders among multinational enterprises revealed that China was the third largest global destination, behind the US and UK; and India was sixth.

Looking deeper at the drivers of locating corporate R&D activities, Thursby and Thursby (2006) stress four outstanding factors: output market potential, quality of R&D personnel, university collaboration, and intellectual property protection. Further, for companies locating in DCs, the growth potential of the local market and the quality of R&D personnel appear particularly important (see also Añon Higón, *et al*., 2011).

Obviously enough, local capabilities and domestic structural change (see previous Sections 2 and 3) – which do play a role in the fruitful importing of ETC and in the learning by export (see previous points B and C) – are *a fortiori* crucial in attracting foreign knowledge-based investments.

Turning our attention to the likely employment impact of this channel of internationalization, it is clear that it is the one more favorable to local employment both in terms of the new jobs directly created by the knowledge-intensive FDI and in terms of those new jobs indirectly created through the demand for suppliers and the R&D spillovers.

4.5 Conclusive remarks

On the whole, emerging economies engaged in catching-up should be able to reach a good match between their own capabilities, domestic innovation and industrial structure and the channels of technology transfer discussed above (see Montobbio, and Rampa, 2005). If such will be the case, they should maximize the beneficial impacts in terms of both productivity growth and economic development. However, this perspective does not assure - *per sé* - an increase in employment, since the new technologies may foster process innovation and be characterized by an intrinsic labor-

[13] This (accelerating) trend has been favored by different factors, such as: (1) the nature of ICT and new technologies which can be split into different stages, characterized by different enabling knowledge (e.g. 'open innovation' in the software industry); (2) the increasing importance of R&D cooperation across firms (see Veugelers, 1997; Cassiman and Veugelers, 2002; Piga and Vivarelli, 2003 and 2004; Amoroso 2017), which renders more likely and profitable the emergence of R&D complementarities between firms located in different areas of the world; (3) the increasing availability of skilled labor and capabilities (see Section 3) in emerging middle income countries such Brazil, Russia, India, China and the EU new member states (see Wood, 1994; Wood and Ridao-Cano, 1999; Meschi and Vivarelli, 2009).

saving nature. If job creation has to be a target, local economic agents and economic policies should favor more the imported ETC in new sectors, the learning by export in high-tech activities and the attraction of R&D labs. Indeed, these three channels of technology transfer appear as the more labor intensive, as detailed above.

In this context, globalization patterns should not be taken as something exogenous, given once for all and passively accepted by the emerging economies. On the contrary, DCs should concentrate their efforts to shape both import liberalization and export-led initiatives in order to maximize a fruitful evolution in terms of structural change, technological upgrading, productivity gains and ultimately employment benefits. For instance, through a policy attracting FDI in the science-based sectors or through public support favoring "learning by export" in the more advanced sectors according to the taxonomies discussed in the previous section (think, for instance, to the possible roles of state-financed export consortia).

5. The impact on domestic skills

While economic theory has mainly dealt with the quantitative employment impact of technological change (see Section 4.1), another more recent and mainly empirical stream of literature has shown that the relationship between technology and employment has a qualitative aspect as well, giving rise to the notion of Skill-Biased Technological Change (SBTC).

The concept of SBTC, first developed by Griliches (1969) and Welch (1970), is based on the hypothesis of capital-skill complementarity, and suggests that employers' increased demand for skilled workers is driven by new technologies that are penetrating into modernized industries, and which only workers with a higher level of skill can operate (see Machin, 2003; Piva and Vivarelli, 2009b).

5.1 The empirical evidence

As already mentioned, the literature on SBTC remains mainly empirical, where many studies indicate that SBTC has gained momentum during the past three decades due to the surge in information technology and spread in computers (Pianta, 2005). The first to explore SBTC empirically were Berman, Bound and Griliches (1994) who provided evidence for the existence of strong correlations between within industry skill upgrading and increased investment in both computer technology and R&D in the U.S. manufacturing sector between 1979 and 1989. Autor, Katz and Krueger (1998) also show that the spread of computer technology in the US since 1970 can in fact explain as much as 30 to 50 percent of the increase in the growth rate of relative demand for skilled labor. Empirical studies supporting SBTC were conducted for several other OECD countries, such as, for example, UK (see Machin 1996, Haskel and Heden, 1999), France (see Mairesse, *et al.*, 2001, Goux and Maurin, 2000), Italy (see Piva and Vivarelli, 2004b), and Spain (see Aguirregabiria and Alonso-Borrego, 2001). Additionally, Machin and Van Reenen (1998) provide evidence of SBTC in a cross-country study on seven OECD countries and again assert a positive relation between R&D expenditure and relative demand for skilled workers.

While most of the literature on the qualitative employment impact of technological change is centered on the developed economies (as was the case with regard to the quantitative employment impact, see Section 4), in recent times some attention has also been devoted to the specificities of the middle-income and low-income DCs.

Starting from a theoretical perspective, according to the mainstream economic theory in the DCs globalization is supposed to have a negative impact in terms of demand for skills: indeed, the Heckscher-Ohlin-Stolper Samuelson (HOSS) model predicts that a DC trading with skill-abundant richer economies should specialize in the production of unskilled-labor-intensive goods and therefore experience a relative increase in the demand for unskilled labor.

In sharp contrast with the traditional mainstream trade theory, if the HOSS unrealistic assumption of homogeneous production functions and identical technologies between countries is relaxed, international openness facilitates technology transfer from advanced to developing countries through the different channels discussed in the previous section, implying that globalization and technological change are complementary and resulting in an increase in the demand for local skilled workers in a given DC (for more extensive analyses, see Vivarelli, 2004 and Lee and Vivarelli, 2004, 2006a and 2006b)[14].

In particular, Robbins (1996 and 2003) and Robbins and Gindling (1999) call the effect of in-flowing technology resulting from trade liberalization the "*skill-enhancing trade (SET) hypothesis*". Their idea is that trade accelerates the flows of physical capital (and embodied technology) to the South, inducing rapid adaptation to the modern skill-intensive technologies currently used in the North. This perspective is quite consistent with the SBTC literature discussed above.

Indeed, the available empirical evidence on the DCs appears to reject the HOSS predictions and to support the SET hypothesis. For example, Berman and Machin (2000 and 2004) found that SBTC had been transferred rapidly from the developed world to at least the middle-income DCs. Meschi and Vivarelli (2009) - once they had disaggregated trade flows according to their areas of origin/destination - found a significant inequality-enhancing effect in middle-income DCs due to trade with more advanced countries, possibly related to technological transfer and skill-enhancing trade. Almeida (2009) reached very similar conclusions using firm-level data for East Asia. By the same token, Conte and Vivarelli (2011), using a direct measure of embodied technological transfer, found that imported skill-biased technological change is one of the determinants of the increase in the relative demand for skilled workers in DCs.

By the same token, the empirical evidence from country-specific studies is also pointing out the links between trade, FDI, technology transfer and skill-upgrading. For instance, Hanson and Harrison (1999), using data on Mexican manufacturing plants, found that firms receiving FDI acquire technology through licensing agreements or imported materials, and tend to hire more skilled workers (see also Feenstra and Hanson, 1997). Görg and Strobl (2002) analyzed a panel of manufacturing firms in Ghana over the '90s; their estimates revealed that while the purchase of foreign machinery for technological purposes significantly raised the relative demand for skilled labor, a greater participation in world markets via exporting activities did not have any effect. Similarly, Fajnzylber and Fernandes (2009) found that increased levels of international integration were associated with an increased demand for skilled labor in a cross-section of Brazilian firms.

[14] In this perspective, Feenstra-Hanson's (1996 and 1997) model points out that what is unskill-intensive in a developed country may be skill-intensive in terms of the labor market of the recipient DC; accordingly, shifting production from developed towards developing countries (both through FDI and import/export trade relationships) may imply increasing inequality both in the former and in the latter. For instance, outsourcing of production through FDI from the U.S. to Mexico implies that plants which were relatively intensive in unskilled labor in the U.S. would be relatively skill-intensive in Mexico (with a higher ratio of skilled/unskilled labor than domestic plants), thus raising relative wages and income inequality in both countries (see also Zhu and Trefler, 2005).

Other papers have instead underlined the skill-enhancing effects of exporting activity, which makes the adoption of new technologies profitable for more firms (see Yeaple, 2005) and induces quality upgrading (see Section 4.3). For instance, Meschi *et al.* (2011) - using a cost-share single equation framework over the period 1980-2001 - study the effect of trade openness on inequality in Turkey. They conclude that both imports and exports contribute to raising inequality between skilled and unskilled workers due to the skill-biased nature of the technologies that are being imported and used in industries with export orientations (see also Meschi *et al*., 2016).

Finally, at least for middle income DCs, together with imported technologies and exports, domestic R&D and innovation may play a relevant role, as it is the case for the most advanced countries. For instance, Meschi *et al*., (2011) showed that SET was an important factor in explaining the rise of the Turkish skilled labor cost share (see above), but together with domestic R&D. By the same token, Araújo *et al*., (2011) also found evidence in support of both the role of SET and domestic technology in determining the skill-upgrading trend of the Brazilian manufacturing labor force. Consistently, Meschi *et al.* (2016) found that domestic R&D expenditures in Turkish manufacturing turned-out to be significantly skill-biased.

As a final remark of this section, it has to be qualified that the SBTC hypothesis has recently been extended to better focus on the precise nature of tasks required to workers. This broader perspective is motivated by a widespread recent evidence of an increasing job polarization in the developed economies, with employment shares and relative wages increasing for both the lowest and highest level of jobs (see Goos and Manning, 2007; Autor and Dorn, 2009).

The standard explanation of this increasing job polarization in the richer economies is the following: while the first decades of the ICT revolution were mainly characterized by the SBTC, more recently the Routine-biased technological change (RBTC) has emerged as the dominant pattern. According to this interpretation, the falling cost of ICT have led to a fast introduction and diffusion of technologies which replace jobs involving routine tasks that are easily programmable (such as administrative and production jobs) but cannot replace non-routine tasks where new technologies - including robots - are complements, and not substitutes of the existing tasks (see Autor *et al.*, 2003; Goos *et al.* 2014; Michaels *et al.*, 2014; Brynjolfsson and McAfee 2014; Frey and Osborne, 2017).

However, all the mentioned studies refer to developed economies where job polarization and RBTC appear to have emerged in recent years. How this pattern of change is actually diffusing (and to what extent) among emerging economies has still to be investigated.

5.2 Conclusive remarks

Summing-up, while emerging economies have to engage in structural change, technological progress and globalization in order to avoid the risk of a MIT and to engage into a further catch-up (see Section 2 and 3), the social consequences of these transformations in terms of jobs, skill-bias and inequality may be controversial. On the one hand, an overall labor-saving impact of the new domestic and imported technologies cannot be excluded (see Section 4) and - on the other hand - globalization and new technologies can likely involve an increase in the demand for skills and possibly an increase in wage and income inequality.

With regard to the strategic industrial and innovation policies already discussed in this paper, policy makers should be aware of the possible labor-saving and skill-biased nature of technological change and globalization. Therefore, accompanying policies should be planned. For instance, given these possible adverse employment and distributional effects, a crucial role has to be attributed to labor-market and education policies, able to maximize job creation, to overcome a possible skill shortage and to smooth income inequality (see next section).

6. Conclusions and policy implications

The main message contained in this paper is that capability building, structural change and technological upgrading should be considered as the most important drivers of a successful catching-up, also able to maximize job creation and minimize the skill mismatch.

Some policy suggestions have been already put forward in the previous sections; here, we will briefly single out again those policy perspectives that appear particular important in facilitating the active enrollment of a DC into a "progressive" globalization trajectory.

- As far as competences and capabilities are concerned (see Section 2), it clearly emerges a role for education policy on the one hand and for labor market policy on the other.

  Education policies should be addressed to provide the necessary basic competences on the basis of which the domestic labor force can build proper and updated capabilities. If such is the aim, emerging economies should not only increase their average years of schooling, but also shape their educational attainment structures to maximize the opportunities to develop social and collective capabilities. From this point of view, it has been showed that formerly middle income countries that successfully engaged in catching-up (like South Korea, Taiwan, Hong Kong, Israel) were those that have been able to strength their lower and upper secondary education levels (see Nübler, 2013).

- With regard to structural and technological change (see Section 3), an impressively important role opens up for industrial and innovation policies. Far from the mainstream economics conventional wisdom considering industrial policies either useless or even harmful, the discussion put forward in this paper supports an opposite view. Indeed, emerging economies should actively engage in supporting structural change and innovation as was – and it still is - the case for the most industrialized countries (see Mazzucato, 2011). As properly discussed by Cimoli *et al*., (2009, ch. 20), state intervention can (must) play a crucial role both in capability building (see previous point) and in fostering a structural and technological change addressed towards the most advanced regimes (see the taxonomies and the discussion put forward in Section 3). Therefore, policies should be highly selective – in order to avoid government failures such as duplications, substitution effects and deadweight effects - and target advanced sectors and technologies, in order to create new absolute advantages, rather than to specialize in the existing comparative advantages (as prescribed by orthodox international economists).

- Turning our attention to globalization, comparative advantages and trade patterns should not be taken as something exogenous, given once for all and passively accepted by the emerging economies. On the contrary, DCs should concentrate their efforts to shape both import liberalization and export-led initiatives in order to maximize a fruitful evolution in terms of structural change, technological upgrading, productivity gains and ultimately employment benefits. For instance, through a policy attracting FDI in the science-based sectors or through public support favoring "learning by export" in the more advanced sectors according to the taxonomies discussed in the Section 3.

- As discussed in Section 4, structural change and technological upgrading do not assure, *per sé*, job-creation; rather, imported technologies may reveal a labor-saving nature, especially when technological change is embodied in imported machinery to be used in agriculture and traditional manufacturing. This means that emerging economies aiming to minimize the possible labor-saving effects connected with technological upgrading should rely on a catching-up based on product innovation (rather than process innovation) and to a structural change addressed to the new and emerging sectors and not at all on the initial comparative advantages in agriculture, commodities and the traditional manufacturing industries, as prescribed by the conventional mainstream trade theory.

- Finally, policy makers in emerging economies should be aware that technological upgrading and globalization are surely generating a skill biased trajectory, in turn increasing inequality and social disparity (see Section 5). From this respect, education and training policies are again absolutely crucial, since an adequate supply of skills can avoid the "skill shortage" and so job-losses and inequality that are associated to a skill-biased technological change (either domestic or imported) not encountering an adequate local supply of skills.

REFERENCES

Abramovitz, M. (1986), Catching Up, Forging Ahead, and Falling Behind, *The Journal of Economic History*, 46, 185-406.

Abramovtiz, M. (1992), Catch-Up and Convergence in the Postwar Growth Boom and After, in: Baumol, W. J., Nelson, R., and E. N. (Eds.): *Convergence of productivity: Cross-country studies and historical evidence*, Oxford, Oxford University Press, 86-125.

Acemoglu, D. (2003), Patterns of Skill Premia, *Review of Economic Studies*, 70, 199–230.

Acemoglu, D., Robinson, J. (2012), *Why Nations Fail: Origins of Power, Poverty and Prosperity*, New York, Crown Publishers (Random House).

Acs, Z.J., Audretsch, D.B. and Feldman, M.P. (1994), R&D Spillovers and Recipient Firm Size, *Review of Economics and Statistics*, 7, 336-40.

Agénor, P.R. and Canuto, O. (2012), Middle-Income Growth Traps, *World Bank Policy Research Working Paper 6210*, Washington DC, World Bank.

Agénor, P.R., Canuto, O and Jelenic, M. (2012), Avoiding Middle-Income Growth Traps, *Economic Premise* ,No. 98, Washington DC, World Bank.

Aghion, P. and Howitt, P., (1998), Capital Accumulation and Innovation as Complementary Factors in Long-Run Growth, *Journal of Economic Growth*, 3, 111–30.

Aguirregabiria, V., and Alonso-Borrego, C. (2001) Employment Occupational Structure, Technological Innovation, and Reorganization of Production, *Labor Economics*, 8, 43–73.

Aitken, B. J.and Harrison, A. E. (1999), Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela, *American Economic Review*, 89, 605-618.

Aiyar, S., Duval, R., Puy, D., Wu, Y. and Zhang, L. (2013), Growth Slowdowns and the Middle-income Trap, *Working Paper 13/71*, Washington DC, International Monetary Fund.

Almeida, R. (20099, Openness and Technological Innovation in East Asia: Have They Increased the Demand for Skills? *IZA Discussion Papers, 4474,* Bonn, IZA.

Altindag, E., Zehir, C. and Acar, A.Z. (2011), Strategic Orientations and their Effects on Firm Performance in Turkish Family Owned Firms, *Eurasian Business Review*, 1, 18-36.

Amoroso, S. (2017), Multilevel heterogeneity of R&D cooperation and innovation determinants, *Eurasian Business Review*, 7, 93-120.

Amsden, A.H. (2001), *The Rise of "The Rest": Challenges to the West From Late-Industrializing Economies*, Oxford, Oxford University Press.

Añón Higón, D., Manjón Antolín, M. and Mañez, J.A. (2011), Multinationals, R&D, and Productivity: Evidence for UK Manufacturing Firms, *Industrial and Corporate Change*, 20, 641-59.

Araújo, B.C., Bogliacino, F. and Vivarelli, M. (2011), Technology, Trade and Skills in Brazil: Some Evidence from Microdata, *Revista CEPAL/CEPAL Review*, 105, 157-71.

Arrow, K. (1962), The Economic Implications of Learning by Doing, *Review of Economic Studies*, 29, 155-73.

Autor, D. and Dorn, D. (2009), This Job Is 'Getting Old': Measuring Changes in Job Opportunities Using Occupational Age Structure, *American Economic Review: Papers and Proceedings*, 99, 45-51.

Autor, D., L. Katz, and Krueger, A. (1998), Computing Inequality: Have Computers Changed the Labor Market? *Quarterly Journal of Economics*, 113, 1169–214.

Autor, D.H., Levy, F. and Murnane, R.J. (2003), The Skill Content of Recent Technological Change: An Empirical Exploration, *Quarterly Journal of Economics*, 116, 1279-1333.

Balassa, B. (1965), Trade Liberalization and Revealed Comparative Advantage, *Manchester School of Economic and Social Studies*, 33, 99-123.

Balassa, B. (1977), 'Revealed' Comparative Advantage Revisited: An Analysis of Relative Export Shares of the Industrial Countries, 1953-1971, *Manchester School of Economic and Social Studies*, 45, 327-44.

Barba Navaretti, G. and Solaga, I. (2002), Weightless Machines and Costless Knowledge - An Empirical Analysis of Trade and Technology Diffusion, *CEPR Discussion Paper N. 3321*, London, Centre for Economic Policy Research.

Barba Navaretti, G., I. Solaga, and Takacs, W. (1998), When Vintage Technology Makes Sense: Matching Imports to Skills, *World Bank Working Paper 1923*, Washington, DC, World Bank.

Bartelsman E., Haltiwanger, J. and Scarpetta, S. (2004), Microeconomic Evidence of Creative Destruction in Industrial and Developing Countries, *World Bank Policy Research Working Paper 3464*, Washington DC, World Bank.

Bell, M. and Pavitt, K. (1995), The Development of Technological Capabilities, in Haque, I.U. (Ed.), *Trade, Technology and International Competitiveness*, Washington, World Bank, 69-101.

Berman, E., Bound, J. and Griliches, Z. (1994), Changes in the Demand for Skilled Labor within U.S. Manufacturing Industries: Evidence from the Annual Survey of Manufacturing, *Quarterly Journal of Economics*, 109, 367-97.

Berman, E., and Machin, S. (2000), Skill-biased Technology Transfer Around the World, *Oxford Review of Economic Policy*, 16, 12–22.

Berman, E. and Machin, S. (2004), Globalization, Skill-biased Technological Change and Labor Demand, in E. Lee and Vivarelli, M. (Eds), *Understanding Globalization, Employment and Poverty Reduction*, New York, Palgrave Macmillan, 39-66.

Bogliacino, F. and Pianta, M. (2010). Innovation and Employment. A Reinvestigation Using Revised Pavitt Classes, *Research Policy*, 39, 799-809.

Bogliacino, F. and Vivarelli, M. (2012), The Job Creation Effect of R&D Expenditures, *Australian Economic Papers*, 51, 96-113.

Bogliacino, F., Piva, M. and Vivarelli, M. (2012), R&D and Employment: An Application of the LSDVC Estimator Using European Data, *Economics Letters*, 116, 56-59.

Brouwer, E. and Kleinknecht, A. (1996), Firm Size, Small Business Presence and Sales in Innovative Products: A Micro-econometric Analysis, *Small Business Economics*, 8, 189-201.

Brouwer, E. and Kleinknecht, A. (1999), Keynes-plus? Effective Demand and Changes in Firm-level R&D: An Empirical Note, *Cambridge Journal of Economics*, 23, 385-91.

Brynjolfsson, E., McAfee, A. (2014), The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. New York: W.W. Norton.

Bustos, P. (2005), *The Impact of Trade on Technology and Skill Upgrading: Evidence from Argentina*, Barcelona, CREI and Universitat Pompeu Fabra.

Calvino, F. and Virgillito, M.E. (2018). The Innovation Employment Nexus: A Critical Survey of Theory and Empirics, *Journal of Economic Surveys*, 32, 83-117.

Cassiman, B. and Veugelers, R. (2002), R&D Cooperation and Spillovers, Some Empirical Evidence from Belgium, *American Economic Review*, 92, 1169-84.

Chung, W., and Yeaple, S. (2008), International Knowledge Sourcing: Evidence from US Firms Expanding Abroad, *Strategic Management Journal* 29, 1207-24.

Cimoli, M. and Dosi, G. (1995), Technological Paradigms, Patterns of Learning and Development: An Introductory Roadmap, *Journal of Evolutionary Economics*, 5, 243-68.

Cimoli, M., Dosi, G. and Stiglitz, J.E. (2009), *Industrial Policy and Development: The Political Economy of Capabilities Accumulation*, Oxford, Oxford University Press.

Cimoli, M. and Porcile, G. (2009), Sources of learning paths and technological capabilities: an introductory roadmap of development processes, *Economics of Innovation and New Technology*, 18, 675-94.

Cimoli, M., Porcile, G. and Rovira, S. (2010) Structural Change and the BOP-constraint: Why did Latin America Fail to Converge?, *Cambridge Journal of Economics*, 34, 389-411.

Coe, D.T., and E. Helpman (1995), International R&D Spillovers, *European Economic Review*, 39, 859–87.

Coe, D.T., E. Helpman and Homaister, A. (1997), North-South Spillovers, *Economic Journal*, 107, 134–149.

Cohen, W.M. and Levinthal, D.A. (1989), Innovation and Learning: The Two Faces of R&D, *Economic Journal*, 99, 569-96.

Cohen, W.M. and Levinthal, D.A. (1990), Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*, 35, 128-52.

Conte, A. and Vivarelli, M. (2011), Imported Skill Biased Technological Change in Developing Countries, *Developing Economies*, 49, 36–65.

Conte, A and Vivarelli, M. (2014), Succeeding in Innovation: Key Insights on the Role of R&D and Technological Acquisition Drawn from Company Data, *Empirical Economics*, 47, 1317-1340.

Daude, C. and Fernandez-Arias, E. (2010), *On the Role of Productivity and Factor Accumulation in Economic Development in Latin America and the Caribbean*, Washington, Inter-American Development Bank.

Doner, R.F. and Ross Schneider, B. (2016), The Middle-Income Trap: More Politics than Economics, *World Politics*, 68, 608–44.

Dosi, G. (1982), Technological Paradigms and Technological Trajectories, *Research Policy*, 11, 147–63.

Dosi, G. (1988), Sources, Procedures and Microeconomic Effects of Innovation, *Journal of Economic Literature*, 26, 1120-71.

Dosi, G., Pavitt, K. and Soete, L. (1990), *The Economics of Technical Change and International Trade*, New York University Press, New York.

Dosi, G. and Nelson, R.R. (2013), The Evolution of Technologies: An Assessment of the State-of-the-Art, *Eurasian Business Review*, 3, 3-46.

Eichengreen, B., Park, D. and Shin, K. (2012), When Fast-Growing Economies Slow Down: International Evidence and Implications for China, *Asian Economic Papers*, 11, 42-87.

Eichengreen, B., Park, D. and Shin, K. (2013), Growth Slowdowns Redux: New Evidence on the Middle-income Trap, *Working Paper No. 18673*, Cambridge Mass, National Bureau of Economic Research.

Epifani, P. (2003), Trade Lliberalization, Firm Performance, and Labor Market Outcomes in the Developing World: What can we Learn from Micro-level Data? *Policy Research Working Paper Series*, *3063*, Washington, DC, World Bank.

Fagerberg, J. (1994), Technology and International Differences in Growth Rates, *Journal of Economic Literature*, 32, 1147-75.

Fagerberg, J. and Godinho, M. M. (2005), Innovation and Catching-up, in J. Fagerberg, D. Mowery and Nelson R.R., (Eds.), *Handbook of Innovation*, Oxford, Oxford University Press, 514-42.

Fajnzylber, P., and Fernandes, A. (2009), International Economic Activities and Skilled Labor Demand: Evidence from Brazil and China, *Applied Economics*, 41, 563–77.

Falk, M. and Hagsten, E., (2018), Employment Impacts of Market Novelty Sales: Evidence for Nine European Countries, *Eurasian Business Review*, 8: 119.

Feenstra, R. and Hanson, G. (1996). Globalization, Outsourcing, and Wage Inequality, *American Economic Review*, 86, 240-245.

Feenstra, R.C., and Hanson, G.H. (1997), Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras, *Journal of International Economics*, 42, 371–93.

Feldmann, H. (2013), Technological Unemployment in Industrial Countries, *Journal of Evolutionary Economics*, 23, 1099–1126.

Felipe, J., Abdon, A. and Kumar, U. (2012), Tracking the Middle-income Trap: What is it, Who Is in It, and Why? *Working Paper n. 715*, Annandale-on-Hudson, Levy Economics Institute.

Felipe, J. & Kumar, U. and Abdon, A. (2014), How Rich Countries Became Rich and why Poor Countries Remain Poor: It's the Economic Structure…Duh!, *Japan and the World Economy*, 29, 46-58.

Felipe, J., Kumar, U. and Galope, R. (2017), Middle-income Transitions: Trap or Myth?, *Journal of the Asia Pacific Economy*, 22, 429-453.

Florida, F. (1997), The Globalization of R&D: Results of a Survey of Foreign-affiliated R&D Laboratories in the USA, *Research Policy*, 26, 85-103.

Freeman, C. (1987), *Technology Policy and Economic Performance. Lessons from Japan*, London, Pinter.

Frey, C.B. and Osborne, M.A. (2017), The Future of Employment: How Susceptible are Jobs to Computerisation?, *Technological Forecasting and Social Change*, 114, 254–280.

Garret, G. (2004), Globalization's Missing Middle, *Foreign Affairs*, 83, 84-96.

Geroski, P. and Walters, C.F. (1995), Innovative Activity over the Business Cycle, *Economic Journal*, 105, 916-28.

Gerschenkron, A. (1962), *Economic Backwardness in Historical Perspective: A Book of Essays*, Cambridge Mass., Belknap Press of Harvard University.

Gill, I., Kharas, H. with Bhattasali D. *et al.* (2007), *An East Asian Renaissance: Ideas for Economic Growth*, Washington DC, World Bank.

Gill, I. and Kharas, H. (2015), The Middle-Income Trap Turns Ten, *Policy Research Working Paper Series n. 7403*, Washington DC, World Bank.

Goos, M. and Manning, A. (2007), Lousy and Lovely jobs. The Rising Polarization of Work in Britain, *Review of Economics and Statistics*, 89, 118-133.

Goos, M., Manning, A. and Salomons, A. (2014), Explaining Job Polarization: Routine-biased Technological Change and Offshoring, *American Economic Review*, 104, 2509-2526.

Görg, H., and Strobl, E. (2002), Relative Wages, Openness and Skill-Biased Technological Change, *IZA Discussion Papers 596*, Bonn, IZA.

Goux, D. and Maurin, E. (2000). The Decline in Demand for Unskilled Labor: An Empirical Analysis Methods and its Application to France, *Review of Economics and Statistics*, 82, 596-607.

Griliches, Z. (1969), Capital-skill Complementarity, *Review of Economics and Statistics*, 51, 465–68.

Grimalda, G. and Vivarelli, M. (2010), Is Inequality the Price to Pay for Higher Growth in Middle-Income Countries?, *Journal of Evolutionary Economics*, 20, 265-306.

Grossman, G. M., and Helpman, E. (1991), *Innovation and Growth in the Global Economy*, Cambridge (Mass.), MIT Press.

Haile, G., Srour, I. and Vivarelli, M. (2017), Imported Technology and Manufacturing Employment in Ethiopia, *Eurasian Business Review*, 7, 1-23.

Hall, P.H., and Heffernan, S.A. (1985), More on the Employment Effects of Innovation, *Journal of Development Economics*, 17, 151–62.

Hanson, G., and Harrison, A. (1999), Trade and Wage Inequality in Mexico, *Industrial and Labor Relations Review*, 52, 271–88.

Hanson, G., R. J. Mataloni, and Slaughter, M. J. (2005), Vertical Production Networks in Multinational Firms, *Review of Economics and Statistics*, 87, 664-78.

Haskel, J., and Heden, Y. (1999). Computers and the Demand for Skilled Labor: Industry and Establishment-level Panel Evidence from the United Kingdom. *Economic Journal*, 109, C68-79.

Helpman, E., (2006). Trade, FDI and the Organization of Firms, *Journal of EconomicLiterature*, 44, 589-630.

Hidalgo, C., Klinger, B., Barabasi, A. L. and Hausmann, R. (2007), The Product Space Conditions the Development of Nations, *Science*, 317, 482–87.

Hidalgo, C. and Hausmann, R. (2009), "The building blocks of economic complexity, in *Proceedings of the National Academy of Sciences*, 106, No. 26, 10570-75.

Hobday, M. (1995), *Innovation in East Asia: the Challenge to Japan*, London, Elgar.

Hummels, D., Ishii, J. and Yi , K-M., (2001), The Nature and Growth of Vertical Specialization in World Trade, *Journal of International Economics*, 54, 75-96.

Iammarino, S., Piva, M., Vivarelli, M. and von Tunzelmann, N. (2012), Technological Capabilities and Patterns of Innovative Cooperation of Firms in the UK Regions, *Regional Studies*, 46, 1283-1301.

Islam, S. N. (2015), *Will Inequality Lead China to the Middle Income Trap?*, Working Papers 142, United Nations, Department of Economics and Social Affairs.

Jankowska, A., Nagengast, A. and Perea, J.R. (2012), The Product Space and the Middle-Income Trap: Comparing Asian and Latin American Experiences, *Working Paper No. 311*, Paris, OECD Development Centre.

Jun-Youn K., Tae-Young P. and Lee, K. (2013), Catch-Up by Indigenous Firms in the Software Industry and the Role of the Government in China: A Sectoral System of Innovation (SSI) Perspective, *Eurasian Business Review*, 3, 100-120.

Kaldor, N. (1967), *Strategic Factors in Economic Development*, New York State School of Industrial and Labor Relations, Cornell University.

Keller, W. (2004), International Technology Diffusion, *Journal of Economic Literature*, 42, 752–82.

Klepper, S., (1996), Entry, Exit, Growth, and Innovation over the Product Life Cycle, *American Economic Review*, 86, 562-583.

Klepper, S., (1997), Industry Life Cycles, *Industrial and Corporate Change*, 6, 145-181.

Kleinknecht, A. and Verspagen, B. (1990), Demand and Innovation: Schmookler Re-examined, *Research Policy*, 19, 387-94.

Klevorick, A.K., Levin, R.C., Nelson, R.R. and Winter, S.G. (1995), On the Sources and Significance of Interindustry Differences in Technological Opportunities, *Research Policy*, 24, 185–205.

Kuznets, S. (1955), Economic Growth and Income Inequality, *American Economic Review*, 45, 1-28.

Kuznets, S. (1963), Quantitative Aspects of the Economic Growth of Nations, *Economic Development and Cultural Change*, 11, 1-80.

Lachenmaier, S. and Rottman, H. (2011). Effects of Innovation on Employment: A Dynamic Panel Analysis. *International Journal of Industrial Organization*, 29, 210 -220.

Lall, S. (1992), Technological Capabilities and Industrialization, *World Development*, 20, 165-86.

Lall, S. (2004), The Employment Impact of Globalization in Developing Countries, in Lee, E. and Vivarelli, M. (2004) (Eds), *Understanding Globalization, Employment and Poverty Reduction*, New York, Palgrave Macmillan, 73-101.

Laursen, K. (2014), Revealed Comparative Advantage and the Alternatives as Measures of International Specialization, *Eurasian Business Review*, forthcoming.

Lee, E., and Vivarelli, M. (2004) (Eds.), *Understanding Globalization, Employment and Poverty Reduction*, New York, Palgrave Macmillan.

Lee, E., and Vivarelli, M. (2006a) (Eds.), *Globalization, Employment, and Income Distribution in Developing Countries*, New York, Palgrave Macmillan.

Lee, E. and Vivarelli, M. (2006b), The Social Impact of Globalization in Developing Countries. *International Labour Review*, 145, 167-184.

Lee, K. (2013), *Schumpeterian Analysis of Economic Catch-up: Knowledge, Path-Creation, and the Middle-Income Trap*, Cambridge, Cambridge University Press.

Lee, K. and Malerba, F. (2017), Catch-up cycles and changes in industrial leadership:Windows of opportunity and responses of firms and countries in the evolution of sectoral systems, *Research Policy*, 46, 338-351.

Lewis, A. (1955), *The Theory of Economic Growth*, Homewood IL., Irwin.

Lin, J.Y. (2011). New Structural Economics: A Framework for Rethinking Development, *World Bank Research Observer*, 26, 193-221.

Lucas, R.J. (2002), *Lectures on Economic Growth*, Massachusetts, Harvard University Press.

Machin, D. (2003). The Changing Nature of Labor Demand in the New Economy and Skill-biased Technology Change, *Oxford Bulletin of Economics & Statistics*, 63-S1, 753-776.

Machin, S. and Van Reenen, J. (1998), Technology and Changes in the Skill Structure: Evidence from Seven OECD Countries, *Quarterly Journal of Economics*, 113, 1215-44.

Malerba, F (1992), Learning by Firms and Incremental Technical Change, *Economic Journal*, 102, 845-59.

Malerba, F. and Orsenigo, L. (1995), Schumpeterian Patterns of Innovation, *Cambridge Journal of Economics*, 19, 47-65.

Malerba, F. and Orsenigo, L. (1996), The Dynamics and Evolution of Industries, *Industrial and Corporate Change*, 5, 51-87.

Mankiw, N.G., Romer, D. and Weil, D.N. (1992), A Contribution to the Empirics of Economic Growth, *Quarterly Journal of Economics*, 107, 407–37.

Marsili, O. (2001), *The Anatomy and Evolution of Industries: Technological Change and Industrial Dynamics*, Cheltenham, Elgar.

Marsili, O. and Verspagen, B. (2001), Technological Regimes and Innovation: Looking for Regularities in Dutch Manufacturing, Eindhoven, ECIS- Eindhoven University of Technology, May.

Marsili, O. and Verspagen, B. (2002), Technology and the Dynamics of Industrial Structures: An Empirical Mapping of Dutch Manufacturing, *Industrial and Corporate Change*, 11, 791-815.

Marx, K. (1961). *Capital*. (First edition 1867). Moscow: Foreign Languages Publishing House.

Mayer, J. (2000), Globalization, Technology Transfer and Skill Accumulation in Developing Countries, *UNCTAD Discussion Paper 150*, Geneva, UNCTAD.

Mazzucato, M. (2011), *The Entrepreneurial State*, London, Demos.ó

Melitz, M. (2003), The Impact of Trade on Aggregate Industry Productivity and Intra-Industry Reallocations, *Econometrica*, 71, 1695–725.

Meschi, E., Taymaz, E. and Vivarelli, M. (2011), Trade, Technology and Skills: Evidence from Turkish Microdata, *Labour Economics*, 18, S60-S70.

Meschi, E., Taymaz, E. and Vivarelli, M. (2016), Globalization, Technological Change and Labor Demand: A Firm Level Analysis for Turkey, *Review of World Economics*, 152, 655-680.

Meschi, E. and Vivarelli, M. (2009), Trade and Income Inequality in Developing Countries, *World Development*, 37, 287-302.

Michaels, G., Natraj, A. and Van Reenen, J. (2014), Has ICT Polarized Skill Demand? Evidence from Eleven Countries over 25 Years, *Review of Economics and Statistics*, 96, 60-77.

Mohnen, P. and Hall, B.H. (2013), Innovation and Productivity: An Update, *Eurasian Business Review*, 3, 47-65.

Moncada-Paternò-Castello, P., Vivarelli, M. and Voigt, P. (2011), Drivers and Impacts in the Globalization of Corporate R&D: An Introduction Based on the European Experience, *Industrial and Corporate Change*, 20, 585-603.

Montobbio, F. and Rampa, F. (2005), The Impact of Technology and Structural Change on Export Performance in Nine Developing Countries," *World Development*, 33, 527-47.

Mowery, D.C. (1983), Economic Theory and Government Technology Policy, *Policy Sciences*, 16, 27–43.

Mowery, D. and Rosenberg, N. (1979), The Influence of Market Demand Upon Innovation: a Critical Review of some Recent Empirical Studie, *Research Policy*, 8, 102–53.

Nelson, R.R. and Winter, S.G. (1982), *An Evolutionary Theory of Economic Change*, Cambridge (Mass.), Belknap Press of Harvard University Press.

Newman, C., Rand, J., Tarp, F. and Thi Tue Anh, N. (2013), *Trade Liberalization and Learning-by-exporting: Evidence from Vietnam*, paper presented at the *UNU-WIDER Conference on Learning to Compete: Industrial Development and Policy in Africa*, Helsinki, 24–25 June.

Nübler, I. (2013), Education Structures and Industrial Development: Lessons for Education Policies in African Countries, paper presented at the UNU WIDER Conference on *Learning to Compete: Industrial Development and Policy in Africa*, Helsinki, 24–25 June.

Nübler, I. (2014), Capabilities for Productive Transformation: Learning to Catch Up, in Salazar-Xirinachs, J.M., Nübler,I. and Kozul-Wright, R. (Eds.) *Getting Industrial Policies Right for Growth, Jobs and Learning*, Geneva, ILO and UNCTAD, forthcoming.

Ortega-Argilés, R., Piva, M. and Vivarelli, M. (2014), The Transatlantic Productivity Gap: Is R&D the Main Culprit?, *Canadian Journal of Economics*, 47, 1342-1371.

Pasinetti, L. (1981), *Structural Change and Economic Growth*, Cambridge, Cambridge University Press.

Pavitt K. (1984), Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory, *Research Policy,* 13, 343-73.

Perez-Sebastian, F. (2007), Public Support to Innovation and Imitation in a Non-Scale Growth Model, *Journal of Economic Dynamics and Control*, 31, 3791-821.

Perkins, R., and Neumayer, E. (2005), International Technological Diffusion, Latecomer Advantage and Economic Globalization: A Multi-technology Analysis, *Annals of the American Association of Geographers*, 95, 789–808.

Petit, P. (1995), Employment and Technological Change, in P. Stoneman (Ed), *Handbook of the Economics of Innovation and Technological Change*, Amsterdam ,North Holland.

Pianta, M. (2005), Innovation and Employment, in J. Fagerberg, D. Mowery and Nelson R.R., (Eds.), *Handbook of Innovation*, Oxford, Oxford University Press, 568-98.

Piga, C.A. and Vivarelli, M. (2003), Sample Selection in Estimating the Determinants of Cooperative R&D, *Applied Economics Letters*, 10, 243-6.

Piga, C.A. and Vivarelli, M. (2004), Internal and External R&D: A Sample Selection Approach, *Oxford Bulletin of Economics and Statistics*, 66, 457-82.

Piva, M. (2003), The Impact of Technology Transfer on Employment and Income Distribution in Developing Countries: A Survey of Theoretical Models and Empirical Studies, *International Policy Group Working Paper 15*, Geneva, International Labor Office.

Piva, M. and Vivarelli, M. (2004a), Technological Change and Employment: Some Micro Evidence from Italy, *Applied Economics Letters*, 11, 373-376.

Piva, M. - Vivarelli, M. (2004b), The Determinants of the Skill Bias in Italy: R&D, Organisation or Globalisation?, *Economics of Innovation and New Technology*, 13, 329-347.

Piva, M. and Vivarelli, M. (2005), Innovation and Employment: Evidence from Italian Microdata, *Journal of Economics*, 86, 65-83.

Piva, M. and Vivarelli, M. (2007), Is Demand-pulled Innovation Equally Important in Different Groups of Firms?, *Cambridge Journal of Economics*, 31, 691–710.

Piva, M. and Vivarelli, M. (2009a), Demand-pulled Innovation under Liquidity Constraints, *Applied Economics Letters*, 16, 289-293.

Piva, M. and Vivarelli, M. (2009b), The Role of Skills as a Major Driver of Corporate R&D, *International Journal of Manpower*, 30, 835-852.

Piva, M. - Vivarelli, M. (2018), Technological Change and Employment: Is Europe Ready for the Challenge?, *Eurasian Business Review*, 8, 13-32.

Rawski, T. G. (2002), Recent Developments in China's Labor Economy, Policy Integration Department, International Policy Group, Working Paper No. 11. Geneva, ILO.

Robbins, D. (1996), HOS Hits Facts: Facts Win; Evidence on Trade and Wages in the Developing World, *OECD Technical Paper 119*, Paris, OECD.

Robbins, D. (2003), The Impact of Trade Liberalization upon Inequality in Developing Countries - A review of Theory and Evidence. *ILO Working Paper*, n.13, Geneva, International Labour Organization.

Robbins, D. and Gindling, T.H. (1999), Trade Liberalization and the Relative Wages for More-Skilled Workers in Costa Rica. *Review of Development Economics, 3*, 140-154.

Romer, P.M. (1994), The Origins of Endogenous Growth, *Journal of Economic Perspectives*, 8, 3–22.

Rosenberg, N. (1990), Why do Firms Do Basic Research With their Own Money? *Research Policy,* 19, 165–74.

Rosenberg, N. (1994), *Exploring the Black Box: Technology, Economics, and History*, Cambridge, Cambridge University Press.

Rostow, W. W. (1959), The Stages of Economic Growth, *Economic History Review*, 12, 1-16.

Rugman, A., A. Verbeke and W. Yuan (2010), 'Re-conceptualizing Bartlett and Ghoshal's Classification of National Subsidiary Roles in the Multinational Enterprise,' *Journal of Management Studies*, 48, 253–277.

Scherer, F.M. (1982), Demand-pull and Technological Invention: Schmookler Revisited, *Journal of Industrial Economics*, 30, 225-37.

Schmookler, J. (1962) Economic Sources of Inventive Activity, *Journal of Economic History*, 22, 1-10.

Schmookler, J. (1966), *Invention and Economic Growth*, Cambridge (Mass.), Harvard University Press.

Schumpeter, J.A. (1934), *The Theory of Economic Development*, Cambridge (Mass.), Harvard University Press.

Schumpeter, J.A. (1942), *Capitalism, Socialism and Democracy*, New York, Harper.

Simonetti, R., Taylor, K. and Vivarelli, M. (2000), Modelling the Employment Impact of Innovation: Do Compensation Mechanisms Work?, in Vivarelli, M. and Pianta, M. (Eds.), *The Employment Impact of Innovation: Evidence and Policy*, London, Routledge, 26-43.

Spence, M. (2011), *The Next Convergence. The Future of Economic Growth in a Multispeed World*, New York, Farrar Strauss and Giroux.

Spiezia, V. (2004), Trade, Foreign Direct Investment and Employment: Some Empirical Evidence, in Lee, E., and Vivarelli, M. (Eds.), *Understanding Globalization, Employment and Poverty Reduction*, New York, Palgrave Macmillan, 143-63.

Stiglitz, J., (2002), *Globalisation and its Discontents*, Oxford, Oxford University Press.

Sutton, J. (2012), *Competing in Capabilities: The Globalization Process*, Oxford, Oxford University Press.

Sylos Labini, P. (1969), *Oligopoly and Technical Progress*, Cambridge (Mass.), Harvard University Press.

Taylor, L. (2004), External Liberalization in Asia, Post-Socialist Europe and Brazil, in E. Lee and Vivarelli, M. (Eds), *Understanding Globalization, Employment and Poverty Reduction*, New York, Palgrave Macmillan, 13-34.

Teece, D.J., Pisano, G. and Shuen, A. (1997), Dynamic Capabilities and Strategic Management, *Strategic Management Journal*, 18, 509–33.

Tidd, J., Bessant, J. and Pavitt, K. (2005), *Managing Innovation: Integrating Technological Market and Organizational Change*, London, Wiley.

Thursby, J. and Thursby, M., (2006), *Here or There? A Survey on the Factors in Multinational R&D Location*, Washington DC, National Academies Press.

UNCTAD (2005), Transnational Corporations and the Internationalization of R&D, *World Investment Report*, New York and Geneva, United Nations.

Verhoogen, E.A. (2008), Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector, *Quarterly Journal of Economics*, 123, 489–530.

Veugelers, R. (1997), Internal R&D Expenditures and External Technology Sourcing. *Research Policy*, 26, 303-15.

Vivarelli, M. (1995), *The Economics of Technology and Employment: Theory and Empirical Evidence*, Cheltenham, Elgar.

Vivarelli, M. (2004), Globalization, Skills and Within-Country Income Inequality in Developing Countries, in E. Lee and Vivarelli, M. (Eds.), *Understanding Globalization, Employment and Poverty Reduction*, New York, Palgrave Macmillan, 211-43.

Vivarelli, M. (2013), Technology, Employment and Skills: An Interpretative Framework, *Eurasian Business Review*, 3, 66–89.

Vivarelli, M. (2014), Innovation, Employment, and Skills in Advanced and Developing Countries: A Survey of the Economic Literature, *Journal of Economic Issues*, 48, 123-154.

Vivarelli, M. (2016), The Middle Income Trap: A Way Out Based on Technological and Structural Change, *Economic Change and Restructuring*, 49, 159-193.

Vivarelli, M., and Pianta, M. (2000), *The Employment Impact of Innovation: Evidence and Policy*, London, Routledge.

Von Tunzelmann, N. and Wang, Q. (2003), An Evolutionary View of Dynamic Capabilities, *Economie Appliquée*, 6, 33-64.

Von Tunzelmann, N. and Wang, Q. (2007), Capabilities and Production Theory, *Structural Change and Economic Dynamics*, 18, 192-211.

Wang L. and Wen, Y. (2018), Escaping the Middle Income Trap: A Cross-Country Analysis on the Patterns of Industrial Upgrading, *Federal Reserve Bank of St. Louis Research Division*, working paper n. 2018-001B, St. Louis.

Welch, F. (1970), Education in Production, *Journal of Political Economy*, 78, 35–59.

Winter, S.G. (1984), Schumpeterian Competition in Alternative Technological Regimes, *Journal of Economic Behavior and Organization*, 5, 287-320.

Wood, A. (1994), *North–south Trade, Employment, and Inequality: Changing Fortunes in a Skill-driven World*, Oxford, Clarendon Press.

Wood, A., and Ridao-Cano, C. (1999), Skill, Trade and International Inequality, *Oxford Economic Papers*, 51, 89–119.

World Bank (2012), *China 2030: Building a Modern, Harmonious and Creative Society*, Washington DC, World Bank.

Yeaple, S.R. (2005), A Simple Model of Firm Heterogeneity, International Trade and Wages, *Journal of International Economics*, 65, 1–20.

Zhu, S.C. and Trefler, D. (2005). Trade and Inequality in Developing Countries: A General Equilibrium Analysis, *Journal of International Economics*, 65, 21-48.